OIL, GAS AND PETROCHEMICAL PROCESSING

Petroleum Refiner

APRIL
1959

Special Report

AIR-COOLED EXCHANGERS

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Best Design for the Job 109
How to Specify Coolers 116

TIME SAVER

Estimate Cost of Cooling Towers 119

BETTER GASOLINE

New Processes Remove Paraffins 125

COST CUTTERS

Tips on Instrument Maintenance 139

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Volume 38, No. 4 April, 1959

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Petroleum Refiner

OIL, GAS AND PETROCHEMICAL PROCESSING

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A Quick Look at This Issue

These handy digests permit checking the articles you want to read first. ☑

SPECIAL REPORT ON AIR-COOLED HEAT EXCHANGERS

☐ **Which Cooling Medium—Water or Air? . . .** Don't be fooled! Water may appear to be the obvious answer to your cooling problems, but it is possible air will serve you cheaper and better. Before you make a selection, look over these costs data beginning on **Page 99.**

☐ **Air Wins Even With Water Plentiful . . .** If there's no water, you can be forced to use air cooling. Did you know, however, air can be better even in locations where water is plentiful? See how and why Sohio incorporated air cooling into its new refinery. It's a cost data story, starting on **Page 103.**

☐ **These Items Help Specify Air Coolers . . .** Air fin coolers are not as widely used as the more conventional types of heat exchangers, although the air coolers are sure to get greater usage in the future. Until you get more experience on this equipment, you'll want to look over these items to help you when specifying. Turn to **Page 106.**

☐ **Find the Best Air Fin Cooler Design . . .** Each air fin cooler can require separate design analysis, but here are the primary factors to keep in mind. There is a sample problem to show you how to use data for heat transfer and power requirements. You'll also learn how to save money by using a cooler that is larger than the size for minimum investment. Turn to **Page 109.**

☐ **Field Tests Needed for Air Coolers . . .** Performance tests of air coolers give widely varying results because test procedures and equipment vary widely. So here are some recommendations for test technique, procedure and equipment. You'll also want to review the four test-run examples starting on **Page 115.**

Please Turn Page ➔

FINE PRODUCT CONTROL

is easier with a LJUNGSTROM® AIR PREHEATER

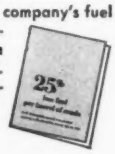
—and finer control means a more uniform, more profitable product

Income is up $58,000 a year at one East Coast refinery because Ljungstrom Air Preheater permits finer control and advanced design units. This boosts average product ratings *as much as two octane numbers.*

The most modern heat transfer system can be operated at peak efficiency with a Ljungstrom gas-to-gas regenerator. A Ljungstrom can recover as much as 1000°F heat from the exhaust of stills or boilers. Instead of letting this heat escape up the stack, the Ljungstrom returns it to the furnace combustion air.

Hotter combustion air can boost the output of a pipe still, too—by as much as 25%. Or, it can cut your fuel bill by an equal amount—or permit you to use cheaper fuels that were previously considered useless. And whatever fuel you use, there's less slag, fewer deposits, because a Ljungstrom Air Preheater helps burn fuel more completely. Some plants have "written off" the cost of their Ljungstroms *in only nine months.*

Here's documented evidence. One company's fuel savings with a Ljungstrom Air Preheater are factually described in a published magazine article by O. F. Campbell. A reprint of this case history is yours free. Simply write:



THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

A Quick Look at This Issue . . .

☐ **How to Estimate Cooling Tower Costs . . .** These data, presented in chart form, permit rapid estimation of induced cooling tower costs. Backing up the data is a detailed estimate which shows less than one percent error from the curves. Clip this time saver, turn to **Page 119.**

☐ **The Texaco Selective Finishing Process . . .** is effective in improving the octane number of full boiling range or light reformates, light straight run naphthas and isomerate stocks. For economic data and pilot plant results turn to **Page 125.**

☐ **The Molex Process . . .** offers the industry a process to accomplish separation of normal paraffins as a class from narrow cuts or from full boiling range gasolines. For the economics and pilot plant results turn to **Page 130.**

☐ **How Good Is the Answer You Report? (Part 2) . . .** In this part of your statistical technique review, you get simplified methods of comparing data from two or more sources. Now you can figure the chances of getting different results from the same determination. Turn to **Page 135.**

☐ **Instrumentation Engineering Cuts Maintenance Costs . . .** Contrary to popular opinion, instrumentation engineering, not the instrument department is the place to cut maintenance costs. Follow these tips on instrument design, specification and installation for economy in maintenance. For complete details, turn to **Page 139.**

☐ **How to Design Tank Heating Coils . . .** has long been plagued with "rules of thumb" and "experience factors." For design methods based on proved data, turn to **Page 143.**

☐ **How Hydrogen Affects Insulation . . .** Normally, thermal conductivities for insulation materials are based on air. Prevent errors in your calculations by using these correction factors for hydrogen atmospheres. **Page 151.**

☐ **Motor Oils Decide Octane Needs Too . . .** Since engine deposits are a function of the motor oil used, here are some points to keep in mind when picking up the components of a good lubricant. These data show how each oil component increases octane requirement. **Page 153.**

☐ **Heat Transfer Nomographs (Part 7) . . . Heat transfer coefficients for liquids and gases inside tubes . . .** Solving heat transfer equations involving fractional powers is time consuming. Here the mass velocity coefficient has been resolved into nomograph form to save you time. Your design notebook will be incomplete without this useful tool on **Page 157.**

☐ **The Solubility of *i*-Butane in Water . . .** Here you'll find experimental and smoothed data for pressures to 320 psia and temperatures to 220 F. **Page 159.**

☐ **Applied Hydrocarbon Thermodynamics (Part 10a.) Charts for Compressor Calculations . . .** These will be a big help to you whenever you wish to make calculations for compressor design. Whether your calculations include the temperature rise of the gas, the work of compression or the compressor size, these charts will save you many hours of hard work. They start on **Page 161.**

☐ **Rumors Can Hurt! . . .** In most companies the grapevine is built-in and can be expected to operate efficiently without regard for the truth of an item or its consequences. In many cases, however, this can cost your organization much money and ruin employe morale. Here is the full story on how a rumor grows and what you can do to stop it. Turn to **Page 223.**

☐ **Engineers—Get the Big Picture! . . .** At last, here is an article which explains why more engineers are not considered for administrative positions. Their specialization does not give them the opportunity to view the over-all, broad and generalized problems of the total management picture of operating a business. You'll improve your scope of thinking, so turn to **Page 230.**

☐ **Are You Paying too Much Overtime? . . .** Look around your refinery. Can you account for all of your overtime costs? Here are some of the main points of the Fair Labor Standards Act which you need to know. There are also some helpful pointers on how you should compute and control overtime costs. Turn to **Page 244.**

Now with 8 important improvements...
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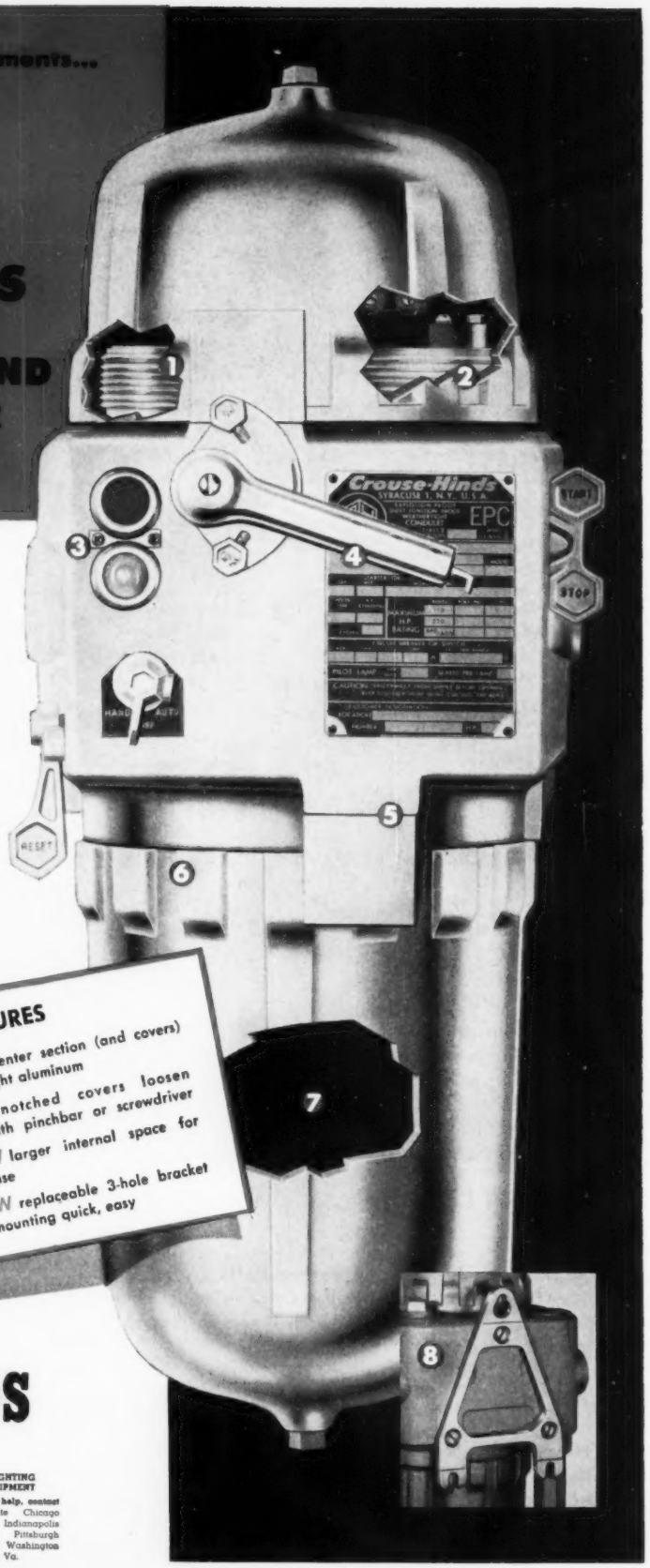
New EPC CROUSE-HINDS EXPLOSION-PROOF MOTOR STARTER AND CIRCUIT BREAKER



The latest refinement in a long-tested, proved and improved explosion-proof combination Motor Starter & Circuit Breaker, this new Crouse-Hinds Condulet® EPC-M59 brings you tomorrow's convenience, dependability and safety at yesterday's prices.

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PETROLEUM REFINER and The REFINERY CATALOG for the oil, gas and petrochemical processing industry.

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PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.

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A Dogeared Boxscore

KNOW WHAT that Midland motel operator first asked after he had greeted Tom Ponder, one of PR's editors?

"Did you bring me a new copy of 'Boxscore'?"

And the reason he wanted a new copy was that the old one which Tom had left with him some months back was still among "the literature" in the lobby but it was dogeared and dirty—obviously much the worse for wear.

Construction Boxscore serves a peculiar need in the oil, gas and petrochemical industry, a need that PR has been meeting now for about a dozen years. Incidentally, there's been some re-vamping as you will note when you reach Page 203 where the current quarterly presentation starts. But the basic information included remains the same.

Permit another "incidentally": We know Boxscore isn't perfect, isn't complete. Readers, and particularly those within the industry connected with construction in any of its phases have been a big help over the years in keeping it up-to-date and complete. *Your* cooperation along this line is earnestly solicited. If you see something that's wrong or know of a project that's not listed, please—and we mean this most sincerely—drop us a memo. We'd appreciate it ever so much and so would all the processing industry.

"Management" Is Six

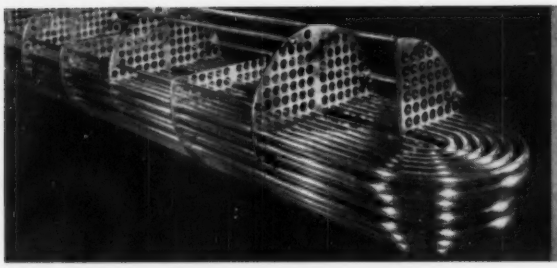
THIS COMMENT from R.J.B., a Los Angeles subscriber affords a text for this Page 7 squib: "PR's management and training articles are the best I've seen in any engineering journal."

PETROLEUM REFINER has been going at these management articles as a separate department now for exactly six years. And we've heard a lot of encouraging words re our efforts. The aim and scope plus actual selection of articles seems to have met a real need within the oil, gas and petrochemical processing field. Commendations come from all sides. For example Subscriber J.A.F., Mississippi, wrote that "Elusive Art of Thinking" and "How to Invent" "were very stimulating and refreshing to read."

Besides interesting present management team members we believe that men within the field who *aspire* to management positions also benefit from this department. Too, fire and safety matters are presented in these pages, but that's another story. Here we would stress the excellence of our management and training articles which stand to benefit almost any alert processing man who chooses to read them.

"As a chemical engineer, it is my opinion that PETROLEUM REFINER *is the best technical journal published."*

That's the studied opinion of one PR subscriber, a man connected with a West Virginia chemical company. Our editorial staff, especially the four chemical enginers, are everlastingly busy producing a magazine that will rate No. 1 in its field; so when comment like the above is received it's music to all ears!



CONDENSER AND HEAT EXCHANGER CLINIC

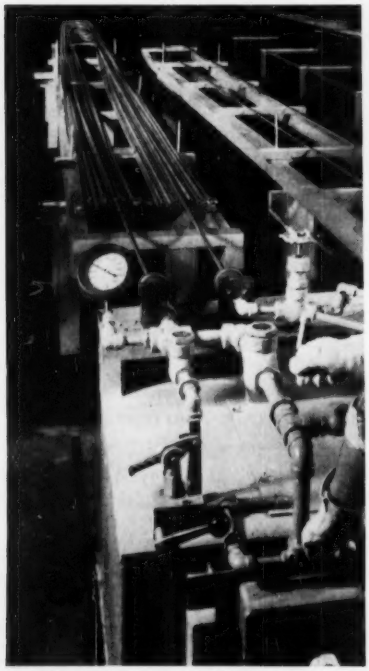
Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, New York

New controls and services meet increasingly critical requirements in heat-transfer units

As steam cycles in turbines become more complex—and operating temperatures and pressures rise—the job of the heat-transfer equipment becomes increasingly critical. Nuclear energy plants place tremendous emphasis on continuity of service for even conventional components like condensers. And in many processing plants the cost of shutdowns may range from exorbitant to disastrous.

Assurance that tubes will meet service requirements becomes increasingly important. And The American Brass Company has augmented its normal quality controls with tests and services to help makers of heat transfer equipment prevent possible trouble before it starts.

Electronic inspection. All tubes are inspected visually one at a time, both internally and externally. However, where greater assurance is required, the tubes—in straight lengths up to 100′—can be inspected electronically by eddy-current equipment.

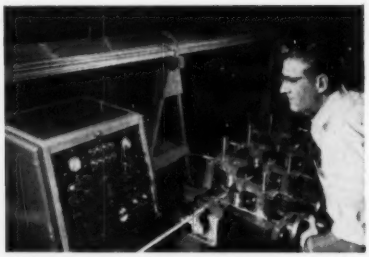


All U-bend tubes are tested hydrostatically at ASME Code pressures—or higher, if necessary.

Hydrostatic testing. As most U-bend tubes are used in applications involving high temperatures and pressures, all of these tubes are tested hydrostatically—after bending—at ASME Code pressures. They can, however, be tested at higher pressures, up to 6000 psi, if the tube size is such that it will withstand the pressure.

Relieving stresses. All U-bend tubes, other than copper, are annealed at the bend area after bending, to eliminate the hazard of stress-corrosion cracking which might occur in service due to stresses that may exist as a result of the bending.

All tubes are inspected visually one at a time, both externally and internally.



When required, tubes are inspected by eddy-current equipment, located at the tube straightener.

Duplex tubes are widely used in chemical plants and petroleum refineries to meet diverse combinations of corrosive action and/or pressure and temperature. Recently designers have selected them for use in air-removal sections of electric-power-plant condensers where corrosion is very severe.

Broadest service. In helping manufacturers and users of heat-transfer equipment meet day-to-day problems, The American Brass Company has a broad background in the latest developments in heat-transfer equipment's expanding role. And with new mill equipment now in place, it offers the broadest service available in tubes for heat-transfer equipment. For technical assistance in special problems, write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5958

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For more data on advertised products, use Readers' Service Cards, last page.

Quick Look at Industry...

Mandatory Controls Bring Many Changes . . .

Recent mandatory controls of oil imports likely to have far-reaching effects on industry. New ceiling now at 1,415,000 bpd——15% below 58's daily average. Importers of finished (except residual fuel) products will be hit hardest. Refiners get quotas on basis of 1958 runs——means every U.S. refiner entitled to quota, even if he has never imported single drop of oil. Until June, though, no one will have imports sliced more than 20%. After that, cushion is dropped.

Basically that's fundamentals of plan——but what does it mean? What will be side effects? Some say domestic crude prices bound to rise. Reason: less oil coming into country——more demand for domestic crude. Others feel prices will tend to drop. Reason: small refiners with new quotas now in better bargaining spot with domestic producers.

With U.S. importing less, prices may skid in some foreign countries. As result, nations may try for bigger bite of oil profits to maintain revenues.

Another point: some think this is first stepping stone to increasing government intervention——eventually resulting in complete crude and product price regulation.

Finally: inland refiners will, of course, swap imported crude for closer domestic source provided by coastal refiners. Some feel this tinges on Socialism——forces traditional coastal importers to subsidize inland refiners.

Liquefied Natural Gas to U.S. . . .

FPC commissioner Connole feels liquefied natural gas will find way to U.S. within 5 years——probably for peak loads on East and West coasts. Also thinks Congress should set policy now on regulation to avoid frustrations like Phillips case.

Chemical Companies—Their Own Customers?

Are chemical companies coming around to using their own plastic pipe? Du Pont claims one process application saved $40,000 using PVC pipe instead of alloys. Also said survey of 10 companies shows definite trend to polyvinyl chloride Type I in thermoplastic pipe field.

Synthetic Rubber Still Gaining . . .

Polyisoprene, nearest thing to natural rubber man can make, now going into truck tires of U.S. Rubber. Produced in small Los Angeles pilot plant by Shell Chemical, synthetic being made and sold at same price as natural. Important point: U.S. could finally be completely free from imported natural rubber in event of war.

Teamsters Get Nod from Union Council . . .

Council for Independent Industrial Workers Union at Esso's Baton Rouge plant voted to recommend 4,000 union members affiliate with Teamsters. Chances are, however, this is just flirtation to improve union's bargaining position——Teamsters won't get in at Baton Rouge or Bayway.

No Shortage of Missile Fuel . . .

Best estimates put hydrocarbon fuel demand for supersonic aircraft and

missiles at about 6,500 bpd. This can be easily met, but costs will soar 5 to 10 times present price of jet fuel.

Industry Eyeing Air-Cooled Heat Exchangers . . .

Air-cooled heat exchangers getting more attention. Big reason: applications found which give lower installation and maintenance costs than with water cooling (more on page 99).

Quick Look Around the Country . . .

Indiana Standard gets Air Force contract to develop special purpose solid fuels and equipment for "Minuteman"—first all solid-fuel ICBM . . . Bay Petroleum plans 50,000 Mcfd natural gas plant on Copono Bay near Rockport, Texas . . . API hires Battelle Institute to research for improving oil burner equipment and developing new fuel oil uses . . . Hudson Engineering gets contract for Humble's giant 600,000 Mcfd King Ranch gas plant . . . Tidewater claims new premium cuts air pollution caused by auto exhaust . . . Directors of The Texas Co., vote to change company name to Texaco, Inc.

New Method to Synthetic Fibers . . .

Propylene—first used for polymer gasoline, then glycerine, hydrogen peroxide and acrolein—now making acrylonitrile for synthetic fibers. By combining propylene and ammonia, Sohio Chemical bypasses usual acetylene-hydrogen cyanide step. Should boost booming acrylic fiber business.

Latest Octane Postings . . .

Average March rating for premium gasoline climbed to 99.1 F-1 octane—up 0.1 from February's mark according to latest Ethyl survey. Regular also increased 0.1 to hit 91.7 F-1 mark.

More Selective Fuels . . .

Octanes needed throughout boiling range of motor fuels. Ethyl's radioactive tracer technique confirms fuel distribution in auto engine according to specific gravity. Thus, one cylinder can be plugged with low quality fuel. Methods being sought to separate poor fuel components for upgrading. Selective adsorption getting eye with Molex and Texaco Selective Finishing (more on page 125).

Petrochemical Growth Looking Good . . .

Petrochemical growth for next 10 years looks good. Annual sales predicted to hit $6.3 billion mark annually by 1969. Breaks down like this: synthetic fibers, $2 billion; organic chemicals, $1.6 billion; plastics, $1.5 billion; elastomers, $600 million; synthetic nitrogen, $400 million; detergents, $200 million. Big question: where will the new plants be located?

Shell Tests Show Gas Turbine Economics . . .

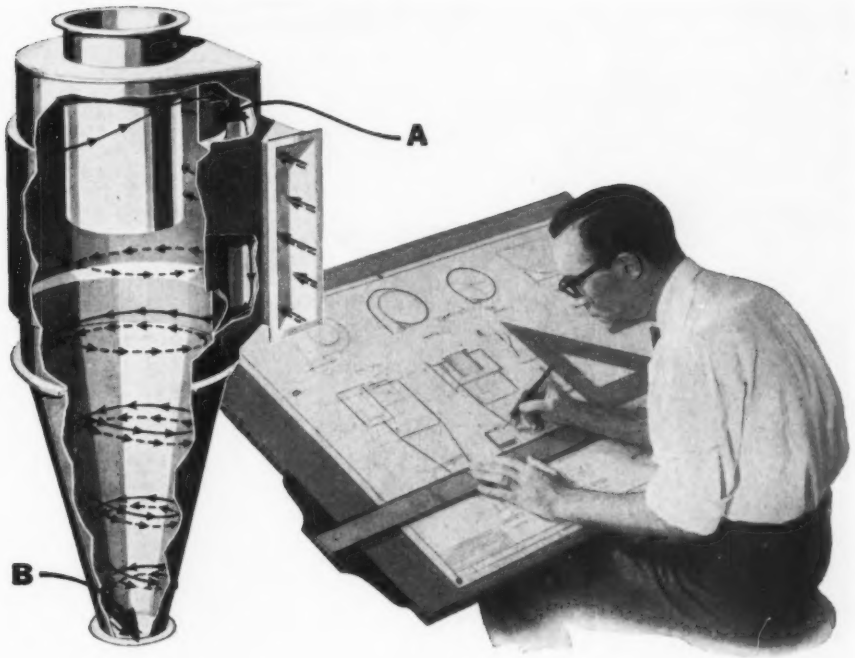
Shell's 4,000-hour test at East Montreal plant shows economics of using catalyst separator and expander gas turbine. Runs off FCC regenerator flue gas and drives regenerator air compressor. Burning 35,000 lb. coke hourly, tests say annual savings can be one-fourth initial capital investment.

TEL Gets New Running Mate . . .

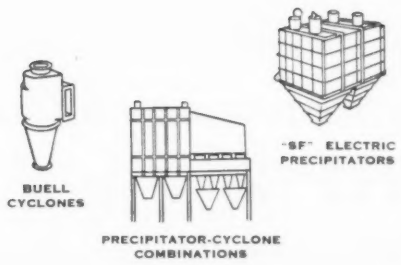
Texaco reveals new additive to help TEL hike octanes. Unlike TEL and refining processes, additive becomes more effective as octanes climb. Thus it's competitive with more expensive upgrading processes.

Long-Range Economy Picture . . .

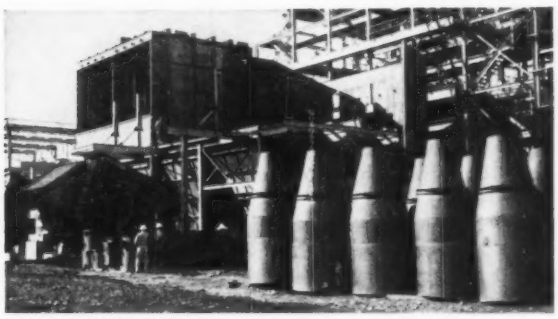
May have answer to old problem of economy fluctuating with seasonal ups and downs. Heretofore, industrial economy hinged on autos, and as Detroit went, so went nation. New thinking, however, says before 1969 autos will follow rather than lead—will be replaced by aeronautical industry which must plan 10 years ahead. Result would be soothing effect on entire economic climate.



The most efficient operating cyclone collectors made



Design makes the difference: in over a thousand plants across the continent, Buell Cyclones have *proved* themselves more efficient than any other cyclones made. Buell's exclusive Shave-off port (A), traps the extra percentage of dust that ordinary cyclones lose. And large-diameter, (B), custom-engineered design eliminates bridging, clogging, or plugging during operation, keeps efficiency high without interruption. Regardless of your present or planned plant layout, Buell equipment can be designed to solve your dust collection problems efficiently and economically. There's valuable information in a concise booklet, "The Exclusive Buell Cyclone". Write Dept. 21-D, Buell Engineering Company, Inc., 123 William Street, New York 38, N. Y.



Buell Cyclones before installation at a major plant.

buell®

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

For more data on advertised products, use Readers' Service Cards, last page.

Add all three selling points with just one additive:

Du Pont RP-2

Now you can pack three potent selling features—anti-rusting, anti-stalling, and self-cleaning—into your gasolines with just one additive, Du Pont RP-2.

CONTROLS RUST. RP-2 forms a barrier between metal and moisture. This blocks rust formation throughout the entire fuel system from gas tank to carburetor. Stops rust during storage at refinery and at service stations, too.

CONTROLS CARBURETOR ICING. RP-2 prevents stalling caused during idling by icing of carburetor throttle plates. Many gasolines require this protection when temperatures range from 22 to 55°F. and relative humidity exceeds 65%.

CONTROLS CARBURETOR DEPOSITS. RP-2 adds a detergent action to your gasolines which not only keeps new carburetors clean, but gradually cleans the throttle plate and throat of carburetors which are already dirty.

CONTAINS PHOSPHORUS. RP-2 contains phosphorus, so you can take a "phosphorus credit" if you're already using phosphorus for control of surface ignition.

For more information on this product and a complete program for marketing its advantages in your gasolines, call in your Du Pont representative or write Petroleum Chemicals Division, E. I. du Pont de Nemours & Co. (Inc.), Wilmington, Delaware.

HOW TO SELL GASOLINE WITH RP-2: This sample advertising kit shows how you can use RP-2 to create new market excitement for your brand of gasoline. See your Du Pont representative or write for the kit.

DU PONT

Better Things for Better Living
. . . *through Chemistry*

Tetraethyl Lead
and other
Petroleum Additives

Boss Prestige Stifling Free Opinion?

Louis E. Wolfson, Chairman of the Board, Merritt-Chapman & Scott Corporation, New York

LAST NOVEMBER, I made a short talk before the Sales Executive Council of the Louisville (Ky.) Chamber of Commerce on the subject, "Robot Executives—A Growing Threat to American Industry." In brief, I described "robot executives" as those men who are not only afraid to try new ideas themselves, but who discourage creative initiative in others; who are so afraid to pioneer that they never dare venture beyond anything that conforms to established precedent. They find it more comfortable to travel in the rut of conformity than to explore new frontiers.

In my talk, I pointed out that this pattern of conformity practiced by business management today, coupled with similar pressures at all levels of our society, threatens to stifle that pioneering spirit of creativity which has made America and American business great. In order that business in the future may not lose this indispensable spirit, I made certain suggestions for its encouragement, through education and through reorientation of thinking and action by business management.

Following delivery, reprints of my remarks were distributed among opinion molders throughout the country, representing many facets of our society. A digest also was carried in our company magazine.

Ripples on a Pond. Like a boy watching the ripples spread from a stone cast into a pond, I have been fascinated by the reaction to my talk, reflected in letters from all over the country, and by requests for hundreds of additional copies for wider distribution. Correspondents have included businessmen, bankers, educators, executives of trade associations, investment advisers, stockholders, congressmen and other government officials. There was widespread agreement with my point of view. The first-hand experiences cited by many of those who wrote confirmed that there needs to be much wider acceptance of the true value of creativity, not only in theory, but in practice.

Evidently I touched on a topic of real concern to thoughtful leaders interested in the economic well-being of our country. Additional evidence of such concern is seen in the increasing number of extended discussions of the problem, now appearing in book form. For instance, on one day recently, the *Wall Street Journal* reviewed three such volumes: *Company Climate and Creativity,* prepared by Deutsch and Shea, Inc.; *Creativity,* edited by Paul Smith, and *The Uncommon Man,* by Crawford H. Greenewalt, president of duPont.

Such increasing visibility for the issue is all to the good. I hope there will be more of it—much more. But I fear that dynamic action generally by those in positions of power to reverse the present trend is still too far in the future.

Educators Concerned. Analyzing correspondence stemming from my "Robot Executives" speech, I note that educators are particularly concerned by the problem. They have already, in many cases, undertaken positive action to reorient business courses toward greater encouragement of the adventurous pioneering spirit in business.

Some who reported these forward steps in the educational world noted, with truth, that business, by and large, is not yet dynamic in taking forward-looking action. Writing of the acknowledged difficulty of walking successfully the fine line between scatter-brain and constructive non-conformity, one correspondent caustically observed, "The so-called 'hard-boiled' businessman is likely to avoid this dilemma by restraining *all* non-conformity. Unhappily he thereby becomes about as solidified in his thinking as a hard-boiled egg, and presses his employes in the same kind of mold."

Wrote another, "Business will not sell itself to the brightest brains of coming generations until business executives not only talk but act like the leaders they proclaim themselves to be."

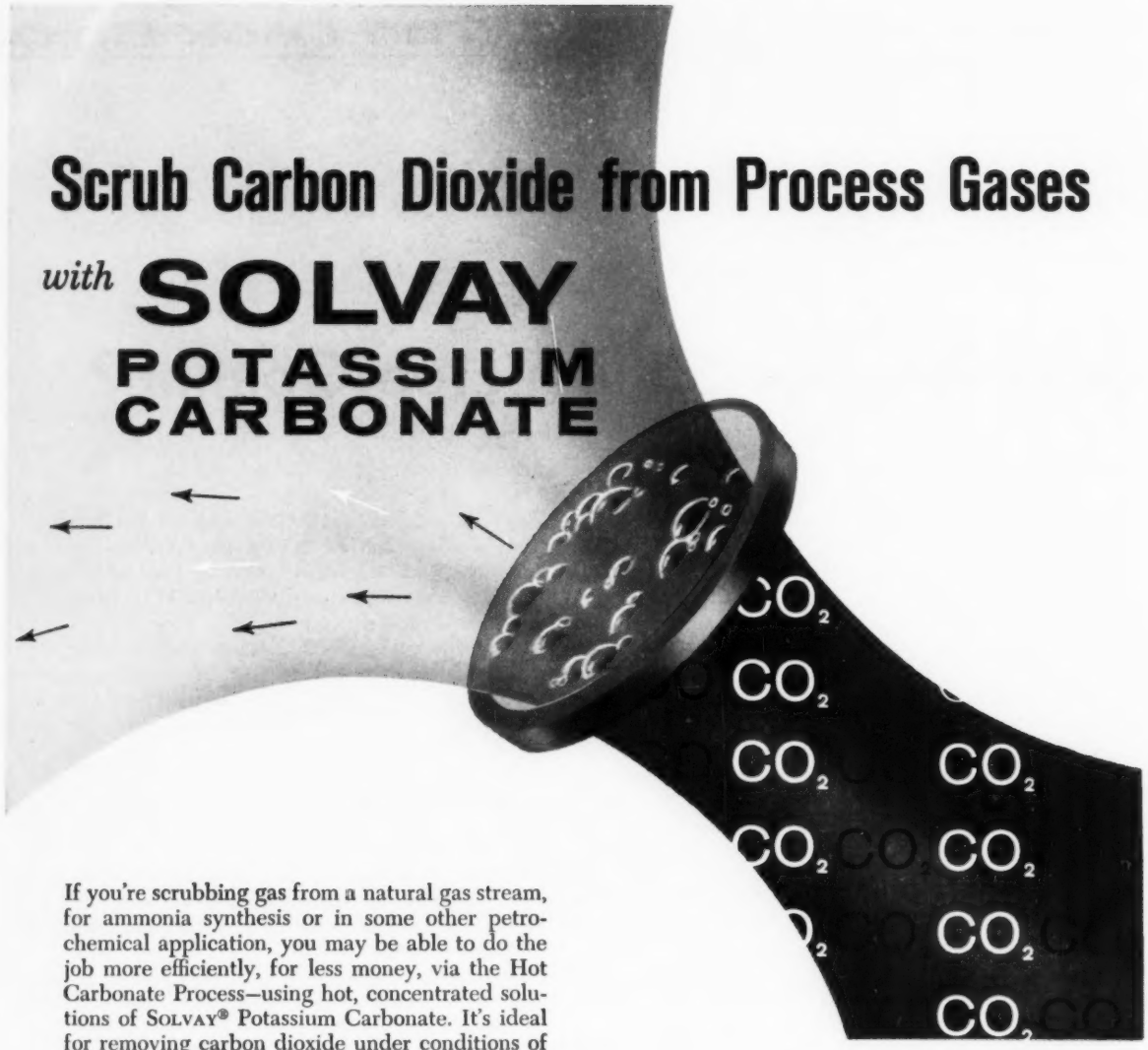
Finally, the dean of one of the most famous of our Graduate Schools wrote, ". . . the features of corporation life with which you are concerned are those that are hardest to recognize, yet in the long run could be most debilitating."

The cult of business conformity has many roots. Obviously it makes for easier relations. It relieves management of "taking a chance." It sets up a precedent for everything—or for nearly everything, including how to stagnate and die.

One precedent, however, it fails to establish—the

Scrub Carbon Dioxide from Process Gases

with SOLVAY POTASSIUM CARBONATE



If you're scrubbing gas from a natural gas stream, for ammonia synthesis or in some other petrochemical application, you may be able to do the job more efficiently, for less money, via the Hot Carbonate Process—using hot, concentrated solutions of SOLVAY® Potassium Carbonate. It's ideal for removing carbon dioxide under conditions of fairly high concentration and partial pressure from process gases.

You save over other methods because the circulating carbonate solution is used hot. This eliminates costly heat exchangers and reduces the process steam requirement.

To help you compare the hot potassium carbonate method with other gas-scrubbing processes, mail the coupon for any of the six authoritative articles from major chemical and petroleum publications or the booklet, "SOLVAY Potassium Carbonate."

Sodium Nitrite • Calcium Chloride • Chlorine • Caustic Soda • Chloroform
Caustic Potash • Potassium Carbonate • Sodium Bicarbonate • Soda Ash
Monochlorobenzene • Para-dichlorobenzene • Ortho-dichlorobenzene
Ammonium Chloride • Methylene Chloride • Carbon Tetrachloride • Vinyl
Chloride • Methyl Chloride • Ammonium Bicarbonate • Hydrogen Peroxide
Snowflake® Crystals • Aluminum Chloride • Mutual® Chromium Chemicals
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- ☐ "CO_2 Removal from Natural Gas"—Oil and Gas Journal.
- ☐ "Economics of Acid-Cas Removal"—Oil and Gas Journal.
- ☐ "Improved Process for CO_2 Absorption"—Chemical Engineering Progress.
- ☐ "Which CO_2 Removal Scheme Is Best?"—Petroleum Refiner.
- ☐ "Florida's First Synthetic NH_3 Plant"—Chemical Processing.
- ☐ "SOLVAY Potassium Carbonate" fact book.

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precedent of how to survive, to grow, to play a dynamic part in safeguarding the economic well-being of our country and of the free world. That precedent was established by pioneering businessmen long before the current worship of conformity and the herd way of conducting business became fashionable.

It is to me a constant source of surprise that the pioneering spirit ever came to be considered outmoded. Creativity gave us the railroad instead of the stagecoach, the steamship instead of the sailing vessel, modern packaging instead of the open cracker barrel. Your own industry's history is a particularly striking example of the pioneering payoff. From the first discovery of how to effect oil-cracking to today's newest techniques, you have literally enabled the wheels of industry and civilization to turn. The pioneer spirit improved the first primitive telephone, put radio and television into millions of American homes, did a thousand and one other things which make possible our modern standard of living.

Creativity Needed Everywhere. This is not to suggest that business pioneering or creativity is merely a matter of technical progress. Creativity and initiative must extend into every facet of the business. We are today in the midst of one of the greatest eras of technical progress of all time, but it merely accentuates the pattern of conformity that is increasingly pervading the business world at large.

How is the present deadening trend to be reversed? If today's youth are to be true enterprisers tomorrow, if the best brains are to be attracted to business, then we who are in business today must pioneer such changes as will make that possible. Those of us who really believe in creativity and the values of nonconformity must constantly encourage others to put our ideas into practice. As I pointed out in my Louisville speech, we must give more people opportunity at every level to make decisions and to base those decisions on their own evaluations. We must lessen the numbing effects of boss prestige when it prevents free expression of opinion. Above all, we must give concrete rewards for individual enterprise and creativity in terms of increased responsibility, freedom of action and monetary gain.

Particularly do I hope that executives in the oil business will be in the forefront of a movement to keep American business dynamic and forward pushing. It seems to me only logical that they should be, for if any field of American business more than another has a tradition of rugged individualism and pioneering creativity, it is oil.

A favorable climate of general public opinion will, of course, make our task as businessmen easier. As I have already indicated, many business schools, at graduate and undergraduate levels, are already keen to orient tomorrow's job applicants toward creative thought and action. That, too, is helpful. But in the final analysis, business, by its own action or inaction must either be the master of its own fate or the victim of its own shortsightedness. Let us see to it that it is not the latter.

No Interest? Then No Squawk

HOW MANY OF YOU reading these pages have written to your senators or representatives lately to express your opinion on important issues of vital concern to the petroleum industry? How many of you looked up and visited with your elected officials when they were back in their districts a short time ago? How many of you have ever taken the trouble to tell them that they must do everything in their power to stop these unwarranted attacks on our great and vital industry?

If you feel a few pangs of conscience as you contemplate these questions, then perhaps you may gain some solace from the fact that certainly, you are not alone. Your attitude is typical of the apathy which seems to have settled like a giant wet blanket over many businessmen and engineers in America today. These are the same businessmen and engineers who failed to give personal attention to how Washington is directly affecting their particular problems.

As we view the trend in Washington today, there is little doubt that our government's role will grow rather than diminish. For a concrete example of this, take a look at the recent presidential proclamation which placed mandatory controls on all foreign oil imports. Above and beyond the fact that imports now are restricted by governmental fiat, is the realization that Washington now really has a finger in the oil pie.

As Felix Wormser, former Secretary of the Interior, said recently, "The business of government has become enormously complex and we Americans have thrust upon the federal government functions that the states, themselves, could equally well perform, and as we assume political and economic responsibilities in the world undreamed of before the destructive wars of recent years. Washington has grown in size to a terrifically complicated government organism—a labyrinth of bureaus, commissions, councils and committees."

Some consider that the government must do the planning for the people. We feel, however, that the reverse is true and that the individual should make his own plans; that an amalgamation of these many individual plans should be the basis for our government. Therefore, we urge that all engineers, for example, take a more active interest in Washington, and, as Mr. Wormser says, "even to the extent of trying for public office, although that isn't absolutely essential.

Taking a look at the last Congress, we can see that there were only two representatives and two senators from engineering ranks.

"Should you, however, as an engineer, get to a political spot that has to wrestle with the thorny economic and legislative problems of our industries," Mr. Wormser continues, "you will be greatly stimulated by the challenge. It is an experience that will give you an inward satisfaction in serving your country that nothing else can replace."

Radioactive tracers pinpoint fuel and additive distribution

Engine equipped to measure fuel distribution and collect exhaust gas condensates from individual cylinders.

Ethyl Research shows how diet of each engine cylinder can be accurately determined

VARIATIONS in the fuel-air mixture ratio from cylinder to cylinder in a gasoline engine affect fuel economy, engine performance, and octane requirement.

This maldistribution also changes the composition of the fuel and the amount of additives received by each cylinder.

For example, one cylinder may receive a mixture with higher antiknock quality than it needs for maximum performance. At the same time another cylinder may raise the octane requirement of the whole engine by not receiving fuel of sufficient antiknock quality.

Fuel injection represents one solution to this problem. Ethyl Research now points the way to other solutions via modification of the present carburetor and tailoring of the fuel and additives.

Until recently it has been difficult to measure the portions of the fuel reaching each individual cylinder. Now accurate determinations can be made, not only of the whole fuel distribution, but also of individual components including additives.

For more data on advertised products, use Readers' Service Cards, last page.

Radioactive Tracer Techniques Provide the Key

Starting with deuterium (hydrogen-2), then carbon-14, and finally tritium (hydrogen-3), Ethyl Research tags hydrocarbon fragments of fuel and additives. Tagged components are blended into a commercial-type fuel, and their distribution is determined by measuring the radioactivity of the exhaust-gas condensate from each cylinder.

The quantity of fuel distributed to the cylinders is measured by an exhaust-gas analyzer of the catalytic-cell type.

Exhaust gas sampling is accomplished by means of an electrically controlled valve equipped with spark plug electrodes. The valve is installed in the regular spark plug hole and functions both as a high-speed (1/1,000 second) sampler and ignition source.

An electrical control system tells the valve precisely when to open during a given engine cycle.

Helpful to Both Oil and Automotive Industries

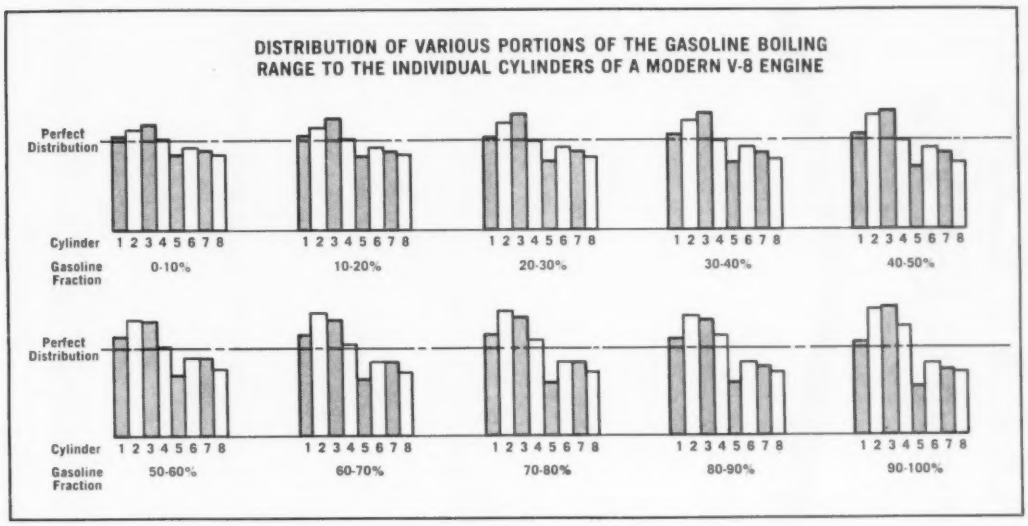
Studies such as this on the subject of fuel distribution to engine cylinders yield data which can be used by both the Petroleum and Automotive Industries in planning future fuels and engines.

A complete description of Ethyl's research on the fuel distribution problem was presented to the Society of Automotive Engineers at their National Winter Meeting in Detroit in January.

Major conclusions of this work are:

1. Uniform fuel distribution can be approached by modification of present carburetor and manifold design.

2. Antiknock quality effects brought about by poor distribution can be reduced by improved formulation of the gasoline blend.



How Ethyl Research is helping you

By exploring all facets of the fuel-engine relationship, Ethyl Research helps protect the refiner against any possible incompatibility of his fuels in the engines in which they will be used.

Ethyl Research findings are continuously made available to the refiner in technical reports, publications, and personal presentations by Ethyl Research Representatives.

Specific information about the fuel distribution problem is contained in the SAE paper entitled "Radioactive Tracers Cast New Light on Fuel Distribution." Your Ethyl Representative will be glad to see that you receive a copy upon request.

ETHYL CORPORATION
NEW YORK 17, N. Y.

ETHYL ANTIKNOCK COMPOUND — ETHYL CORPORATION

RESEARCH LABORATORIES:
1600 W. Eight Mile Road, Ferndale 20, Mich.
2600 Cajon Road, San Bernardino, Calif.

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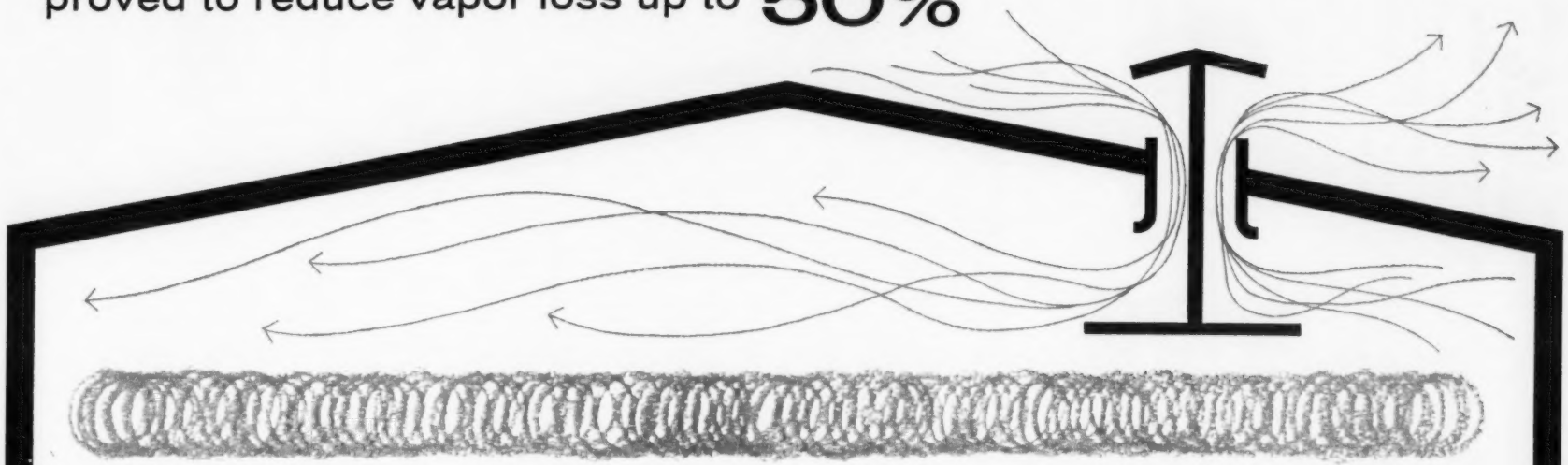
S&J AIR BAFFLE*

proved to reduce vapor loss up to 50%



Downward velocity of air jetting into a tank through the breather vent causes currents which induce rapid product evaporation. S & J Air Baffle is a device which deflects incoming air into stratified layers above heavier, gas-rich air. The result is materially reduced surface boiling, with vapor losses cut from 25 to 50%. Unique Air Baffle design permits simple installation through the vent nozzle on tanks in service. Call or write for complete details and prices.

*Patented

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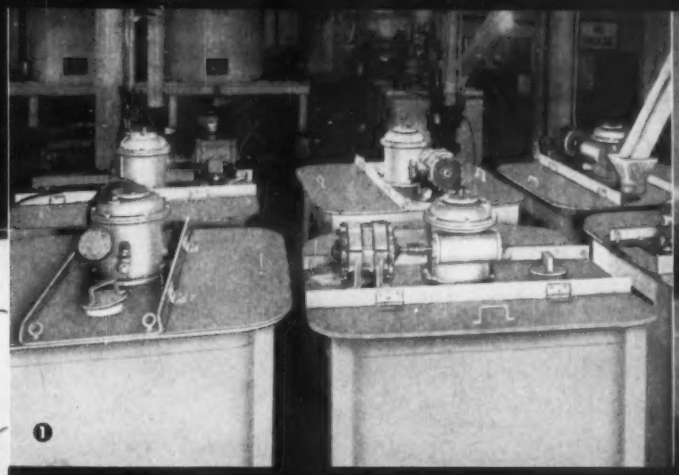
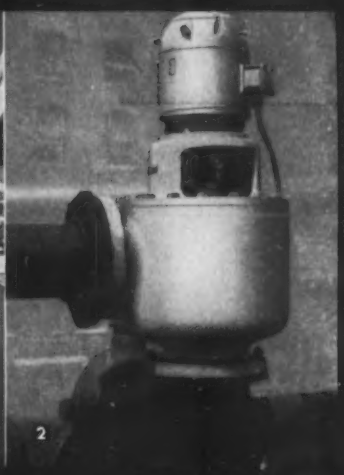
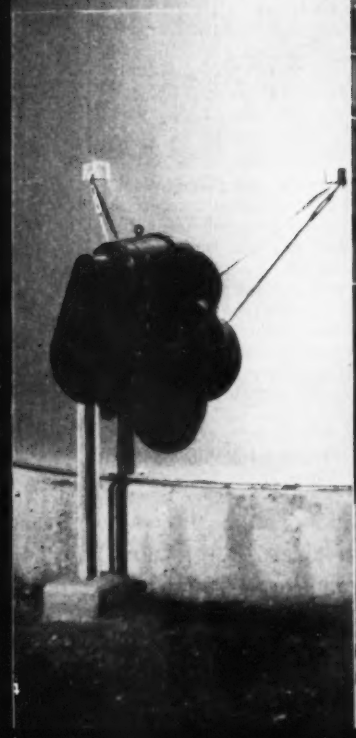
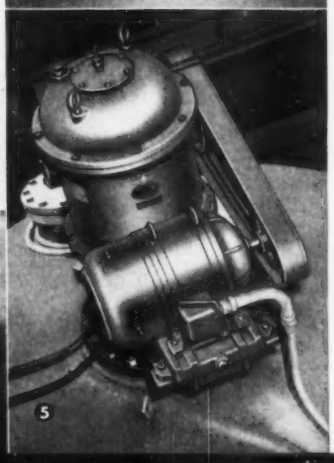




Improved Processing through Engineered Agitation





HOW IMPORTANT IS GOOD FLUID MIXING IN YOUR PROCESS?

REGARDLESS OF HOW SPECIALIZED your particular processing needs are, good mixing can be the difference between "run of the mill" and maximum yields.

NETTCO MIXERS ARE PROCESS-RATED for optimum performance. Your particular process requirement is fully evaluated. And—it costs no more to get the full benefit of Nettco's wealth of agitation technology and broad application experience. Then—from design and pilot test to full process conditions, standard components are precision teamed to provide you with a Nettco mixer to meet your most exacting conditions. If good fluid mixing is vital to your process, then Nettco Engineered Agitation is vital to *you!*

PUT NETTCO ENGINEERED AGITATION TO WORK FOR YOU. From a full line . . . side drive, tank top, portable or tripod and unique continuous pipeline mixers, NETTCO can provide the answers to a wide range of mixing problems. See your NETTCO representative listed in Chemical Engineering Catalog or Refinery Catalog, or write for Bulletin 582, New England Tank and Tower Co., 81 Tileston Street, Everett 49, Mass.

NETTCO

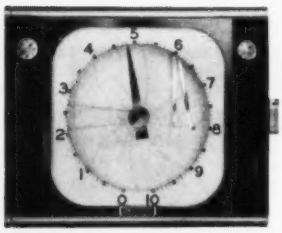
ENGINEERED AGITATION SPECIALISTS

EVERETT 49, MASSACHUSETTS

1. Paint blending with Nettco tank top mixers on 400 gallon portable tanks.
2. Nettco Flomix® in the continuous recycling of waste product to improve yield.
3. Variable speed pilot plant application of Nettco medium speed, propeller drive mixer.
4. Raw material batch blending with Nettco side drive mixer to assure uniformity.
5. 15 year old Nettco tank top mixer for synthetic rubber production with one of first double mechanical seals.

Bristol's 7-point coast-to-coast field service

Helps you from the time you start thinking instruments – through installation – for as long as the job requires



A Bristol Field Engineer is the man to call when you first start thinking about instrumentation. Located in a nearby Bristol office (they blanket the U.S. and Canada) he calls at your plant to assist you in planning your proposed installation. No obligation.

Application Engineers, specialists in the abilities and limitations of every type of instrument, and Process Specialists, experts in instrumentation techniques in varied fields can be called in where necessary. They insure you the right instrument, installation and operation for your specific job.

Service Engineers to keep your instruments operating perfectly are "on call" often within a few hours. They install, check and adjust instruments in your plant.

Periodic Check-up Service at regular intervals is also available.

Bristol's Instrumentation Schools for customer engineers help train your own technicians in instrument operation and maintenance.

Factory Repair Service at San Francisco, Los Angeles, Chicago, Houston, Waterbury and Toronto has all facilities, parts, experience to properly repair, recondition and remodel Bristol instruments. Each instrument reconditioned carries a new instrument warranty.

Fast Parts Service is assured by the Bristol practice of stocking service parts that may be needed in emergencies in all 38 Branch offices. You get fast action from a near-by source.

These big extras you get with Bristol instruments are good reasons—over and above outstanding basic instrument quality—why every Bristol installation gives such high accuracy and precision performance over an extremely long service life. To find out more about Bristol instruments or service, write: The Bristol Company, 111 Bristol Road, Waterbury 20, Conn. B.17

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

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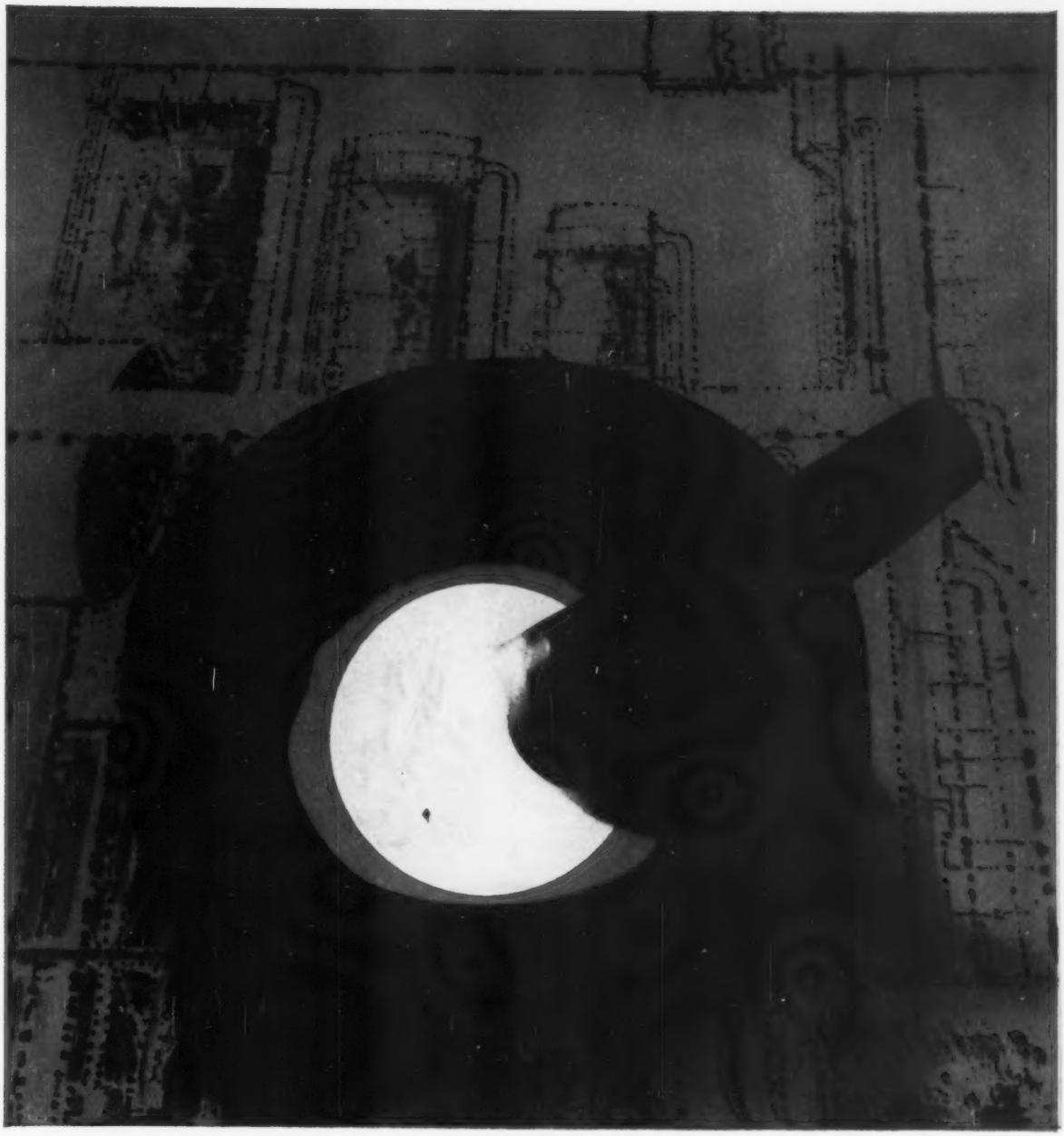

NEW low soda content: another good reason to

mix imagination with Alcoa Hydrated Aluminas

ALCOA now offers you the lowest soda content ever available in commercial grades of hydrated alumina. Typical soda level of new Hydrated Alumina C-35 is only .040% Na_2O . . . making it ideal for use as a noncontaminating catalyst base, or as an ingredient material for fine aluminum chemicals. Here is just one more example of ALCOA's constant effort to match aluminas to product or process needs. It's another good reason why it pays to mix imagination with ALCOA® Aluminas . . . to make an old product better, or a new product possible. There is probably a type and grade of alumina precisely suited to your own needs. You can get complete information by writing ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 708-D Alcoa Building, Pittsburgh 19, Pennsylvania.

For finer products . . . let Alcoa add new dimension to your creative thinking!

ALCOA CHEMICALS

For exciting drama watch "Alcoa Theatre," alternate Mondays, NBC-TV, and "Alcoa Presents," every Tuesday, ABC-TV

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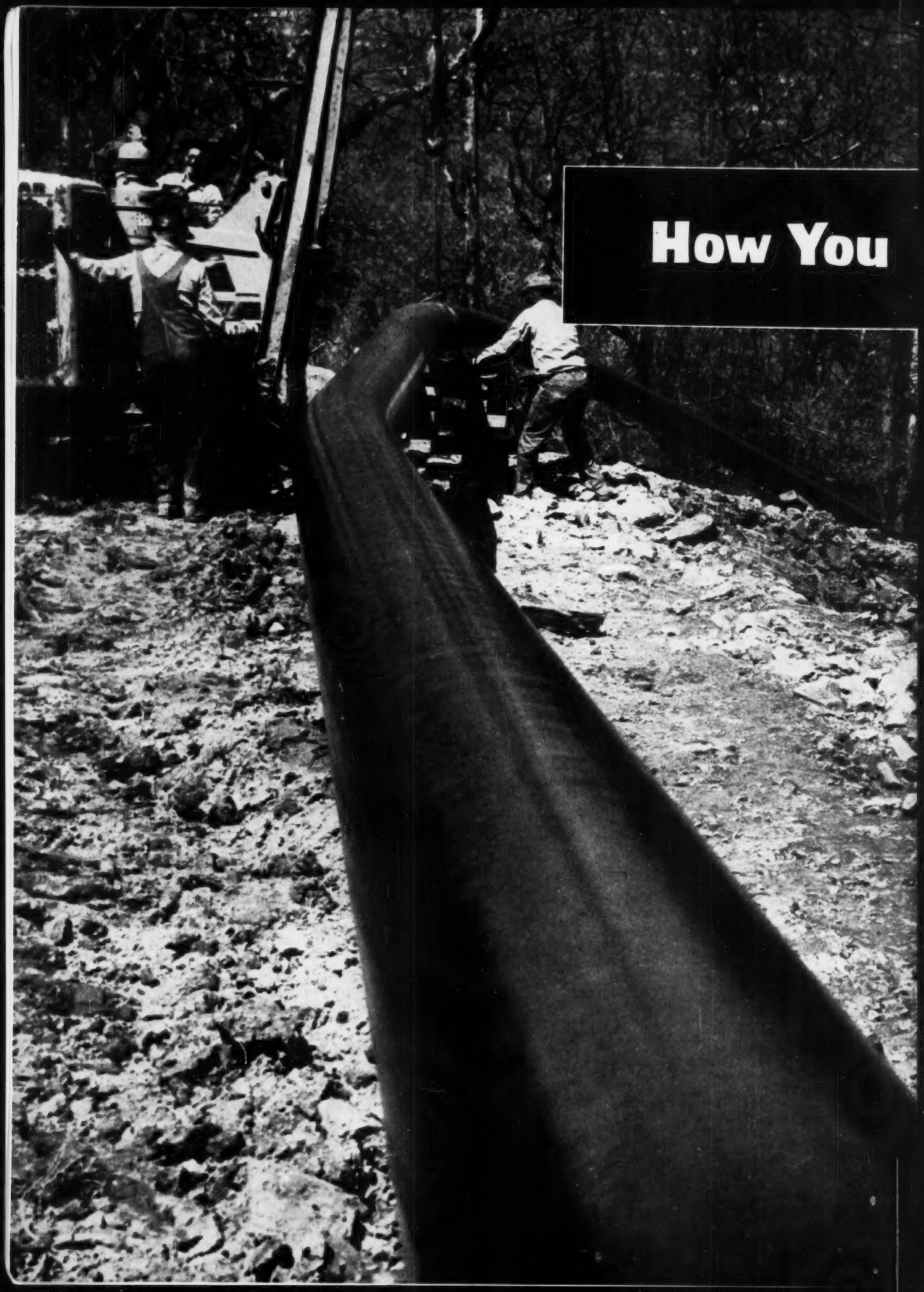

How You

Profit From Multiple Testing

Multiple testing of every length of **J&L Electricweld Line Pipe** is your assurance of better performance during installation and operation.

(1) Every length is pressure-tested under the specified A.P.I. or A.S.T.M. hydrostatic test requirement both in time and in degree of pressure. Pneumatic hammers strike the pipe while it is under pressure to build up pressure surge.

(2) A series of visual inspections is made on each length of **J&L Electricweld.**

(3) Each length of pipe is given a crush test to determine weld strength and steel quality. The test complies with requirements of A.P.I. 5L, 5LX and with A.S.T.M. A-53, A-135 and equivalent specifications.

(4) Both ends of each joint of **J&L Electricweld Line Pipe** receive a magnaflux examination.

Discover how you can profit by using this high quality pipe in your next line by calling your local J&L Supply man today. Remember if it's sold by J&L... it's the best available.

J&L Electricweld is available in sizes 6⅝" O.D. through 12¾" O.D.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

If it's sold by J&L....
It's the best available

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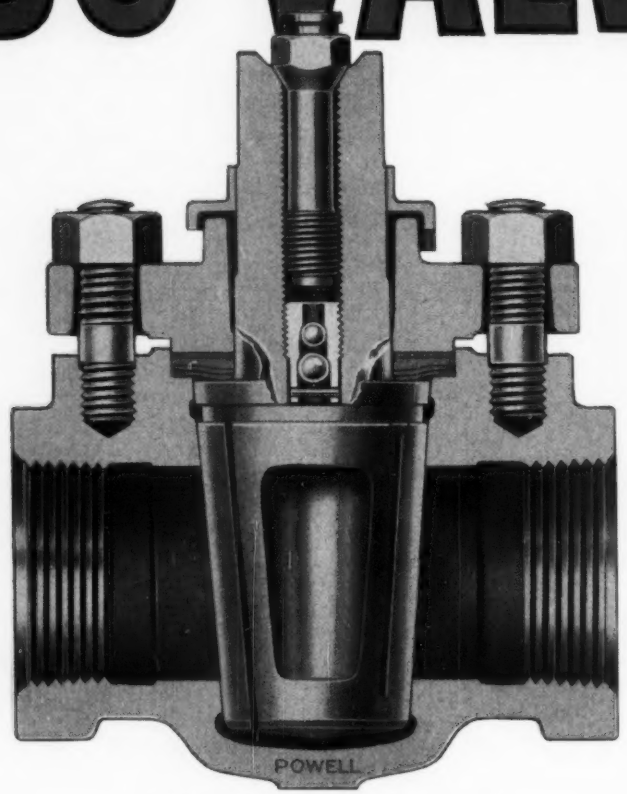
POWELL
LUBRICATED PLUG VALVES



Sectional-Powell Lubricated Plug Valves, Single Gland type. Also available with Flanged Ends.

Powell Lubricated Plug Valves have many advantages over conventional types of Valves:

- Simple design: only 3 basic parts—body, bonnet, plug.
- Quick, complete shut-off.
- Tapered Plug assures positive seating.
- Machined surfaces of plug and body are not exposed in open position.
- Cavity-free straight passage assures streamlined flow.

Available in sizes ½", through 16", depending on the type required—semi-steel 175 and 200 pounds WOG; carbon-steel ASA 150 and 300 pounds. Also in other alloys on special order.

For complete information, write for our new Lubricated Plug Valve Catalog, Number PV-5. Or contact your local Powell Distributor.

The Wm. Powell Company • Cincinnati 22, Ohio
Dependable Valves Since 1846

POWELL...world's largest family of valves

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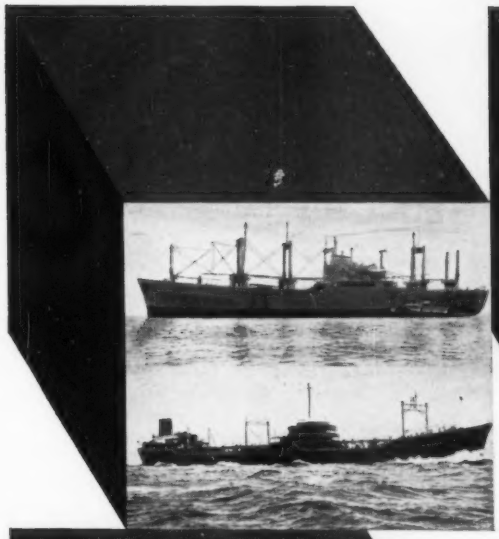

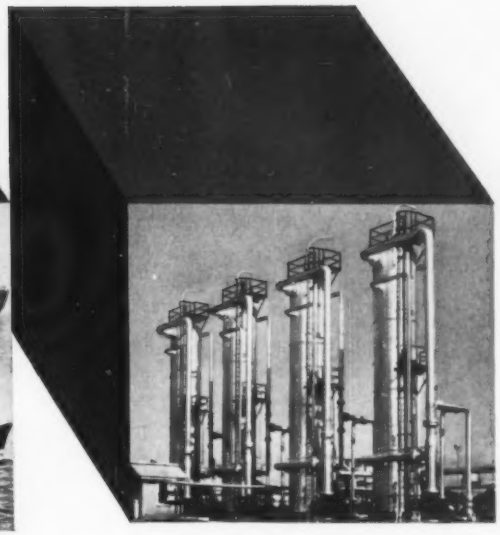

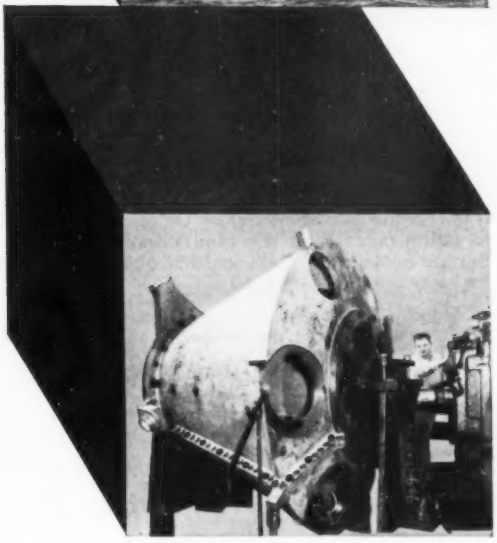

MASTER BUILDERS FOR LAND AND SEA

For more than forty years, engineering leaders in the oil-refining and chemical industries have been calling upon Sun Ship for important components for the building of large plants.

- Manufacturing and fabricating skill that has kept pace with the growth of their great industries . . . and understanding of their problems.
- Facilities and craft skills that can produce . . . and deliver . . . the equipment needed—swiftly.
- A special . . . separate . . . Alloy Products Shop equipped to produce medium and heavy stainless alloy and aluminum products for industry.

BUILDING FOR LAND Pressure Vessels • Fractionating Towers • Stills and Tanks • Condensers and similar equipment • Special Machinery • Plate Work, etc.

BUILDING FOR SEA Dry Cargo Ships • Tankers • Marine Repairs • Dredges, Ferries • Marine Engines • Marine Machinery

Your inquiries will receive our prompt attention

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SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • SINCE 1916 • CHESTER, PA.

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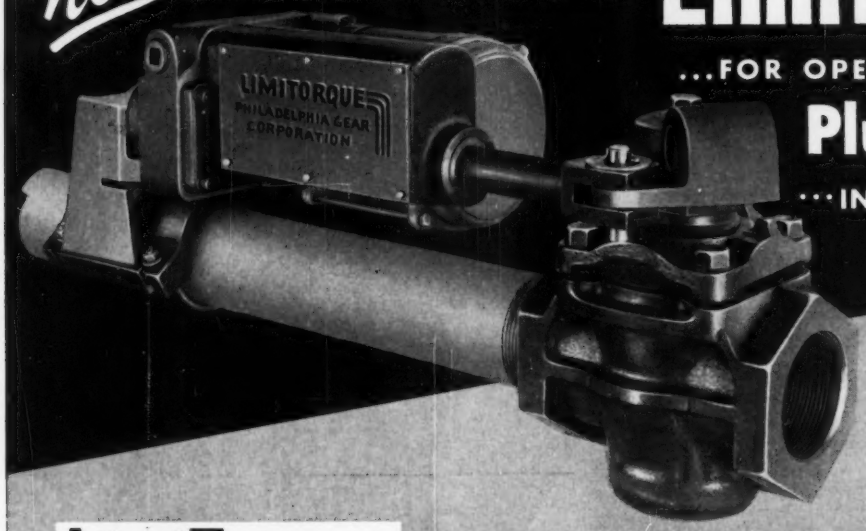
New AN AUTOMATIC, COMPACT **LimiTorque**

...FOR OPERATING YOUR

Plug Valves

...IN 8 TO 16 SECONDS



LimiTorque LINEAR MOTORIZED VALVE OPERATOR

...a dependable time, labor and money saver

Another LimiTorque *first* — here's the answer to the problem of motorizing your wrench (hand) operated Plug Valves . . . a simple, easily installed unit that can be built either to NEMA IV (weather-proof), or NEMA VII (explosion-proof) standards . . . an inexpensive, sturdy, fully reliable and extremely compact assembly that requires no gear changes or modifications, other than to supply a motor with the proper output speed. The *LimiTorque Linear Operator* consists of motor and double reduction gearing which drive a traveling screw and a crank that is easily mounted to the square shank of plug valve.

As noted in the illustrations, the entire assembly can be readily adapted to your plug valve while in service, by merely mounting the crank on the plug shank and strapping the support bracket to the pipe . . . The *Linear Operator* is supplied with all necessary adapting parts such as the support bracket and straps for mounting on the pipeline; also the necessary crank arm for mounting on the square shank of valve plug — The entire construction and operation is indeed simple . . . and the purchase price and installation costs are comparatively low.

A torque of 175# is developed at the valve, which is normally more than enough to drive most wrench-operated plug valves up to 6" in size. If power fails, or manual operation is desired, the mere removal of a pin (which connects the traveling screw to the crank arm) will divorce the crank from the *Linear Operator* assembly — and a bar placed in the bushed bore of the crank arm will operate the valve. (No special wrench is needed.) The mere flick of a switch to the direction of travel desired will operate the valve . . . Contact your valve manufacturer, or your nearest LimiTorque Sales Engineering Office.

Full details on this *new LimiTorque Linear Operator* are contained in Bulletin 20-58 . . . send for copy on your business letterhead.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

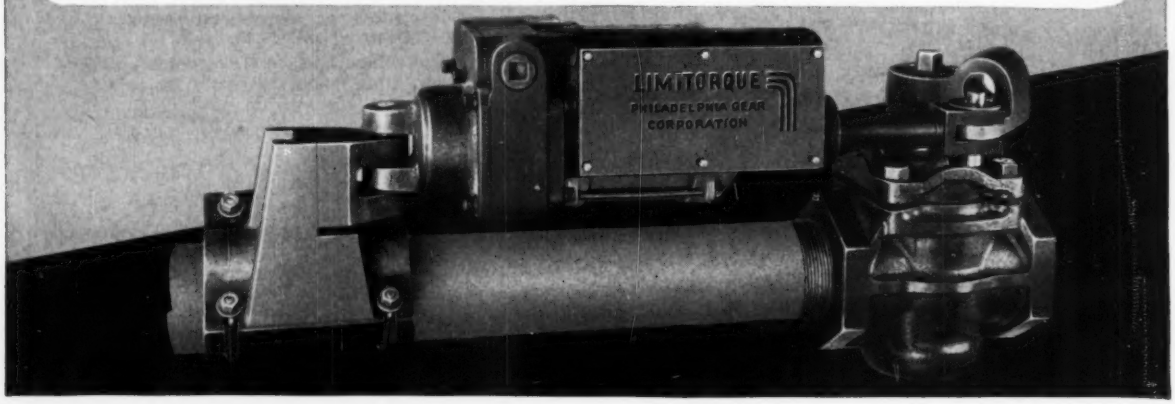
PHILADELPHIA GEAR CORPORATION

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

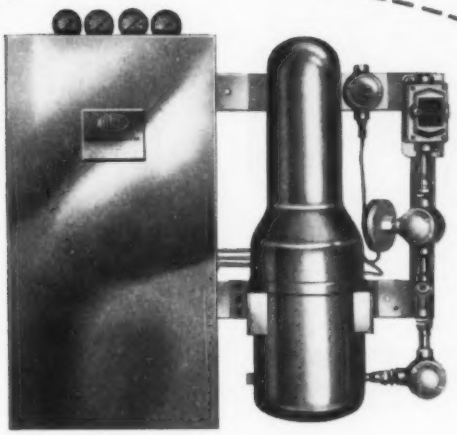
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS
LIMITORQUE VALVE CONTROLS
FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia



FOR MAXIMUM YIELD



LOWER CONTROL COSTS.

THE NEW TOTCO *continuous* END-POINT ANALYZER

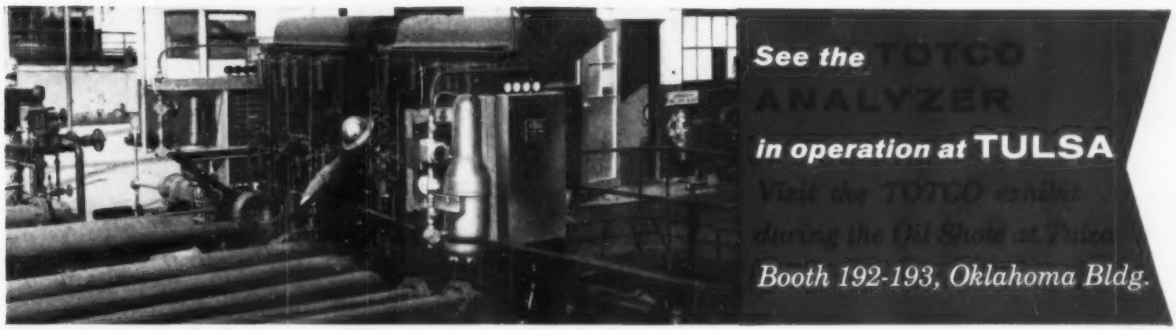
TOTCO's *continuous* End-Point Analyzer pays its own way in profits . . . by giving refinery operators a new and unique control over product quality and yield. This sensitive instrument is always on the job —right at the operating unit — for the *continuous* analysis of any petroleum product where the end boiling point is critical.

It automatically indicates the Engler End Point of a hydrocarbon stock or commodity in an operating range of 200°F. to 600°F.

The unit responds immediately to any variation in the end boiling point of the sample, and its *continuous* signal may be fed directly to a controller as well as to a recording chart. It delivers reproducibility within ±1°F., with results that correlate with ASTM D-158 or ASTM D-86.

Depend on this TOTCO Analyzer to reduce control costs by saving time. Its *continuous* analysis cuts the usual delays between quality change and compensating plant control...eliminates the time lag of batch analyzers or conventional laboratory tests.

Write or call today for further information.


See the TOTCO ANALYZER
in operation at TULSA
Visit the TOTCO exhibit during the Oil Show at Tulsa
Booth 192-193, Oklahoma Bldg.

TOTCO continuous End-Point Analyzer in operation at Union Oil Company Refinery, Wilmington, California.

TOTCO

TECHNICAL OIL TOOL CORPORATION

1057 North La Brea Avenue, Los Angeles 38, California • OLdfield 4-1763

MANUFACTURERS OF PRECISION INSTRUMENTS SINCE 1929

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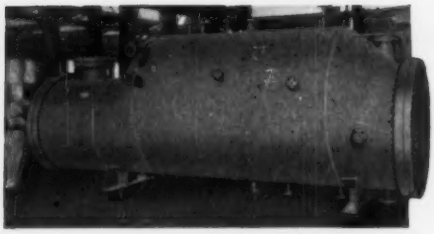
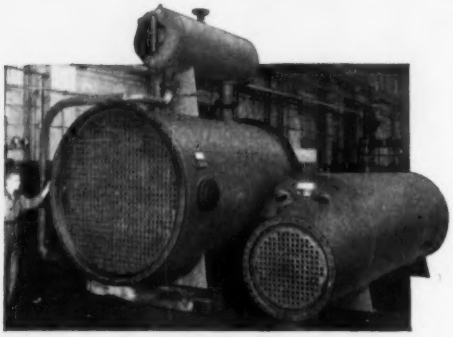


1 A nitric acid plant installed this unit. It has a built-in platinum catalyst chamber.



2 A methanol plant operates these horizontal type units.

5 TYPES OF *Waste Heat* STEAM GENERATORS

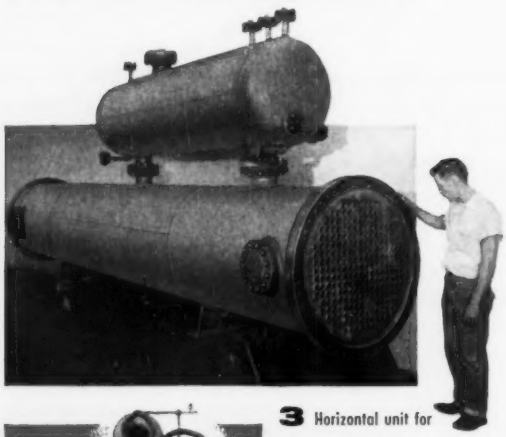
Each of the units shown were custom designed to solve the specific problems peculiar to individual plant processes.

Vogt engineers are available to help you develop the right equipment to efficiently provide low cost steam from process heat. There's no obligation.

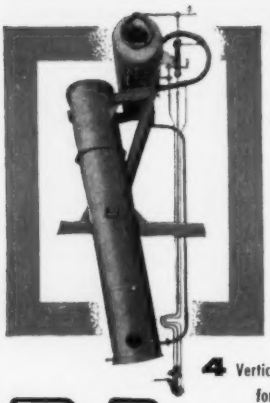
Write for Literature — Address Dept. 24A-XPR

HENRY VOGT MACHINE COMPANY
LOUISVILLE, KENTUCKY

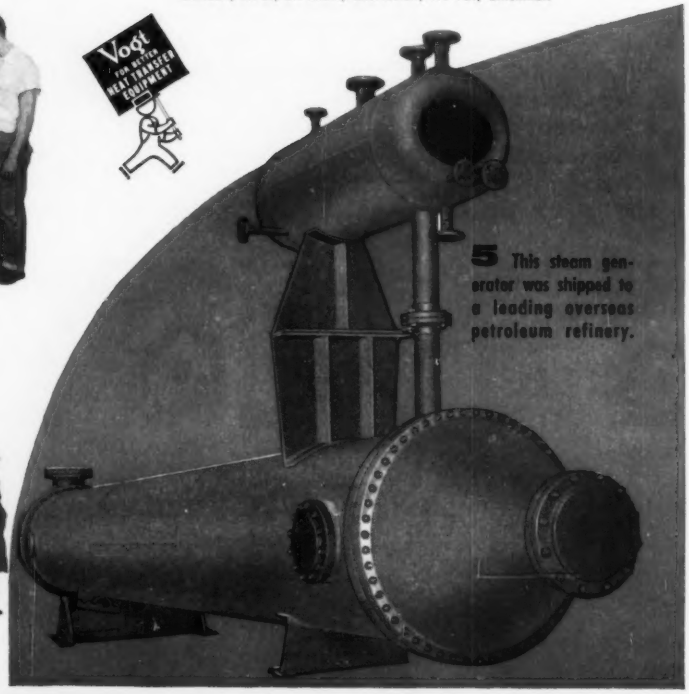
SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati



3 Horizontal unit for a nitric acid plant.

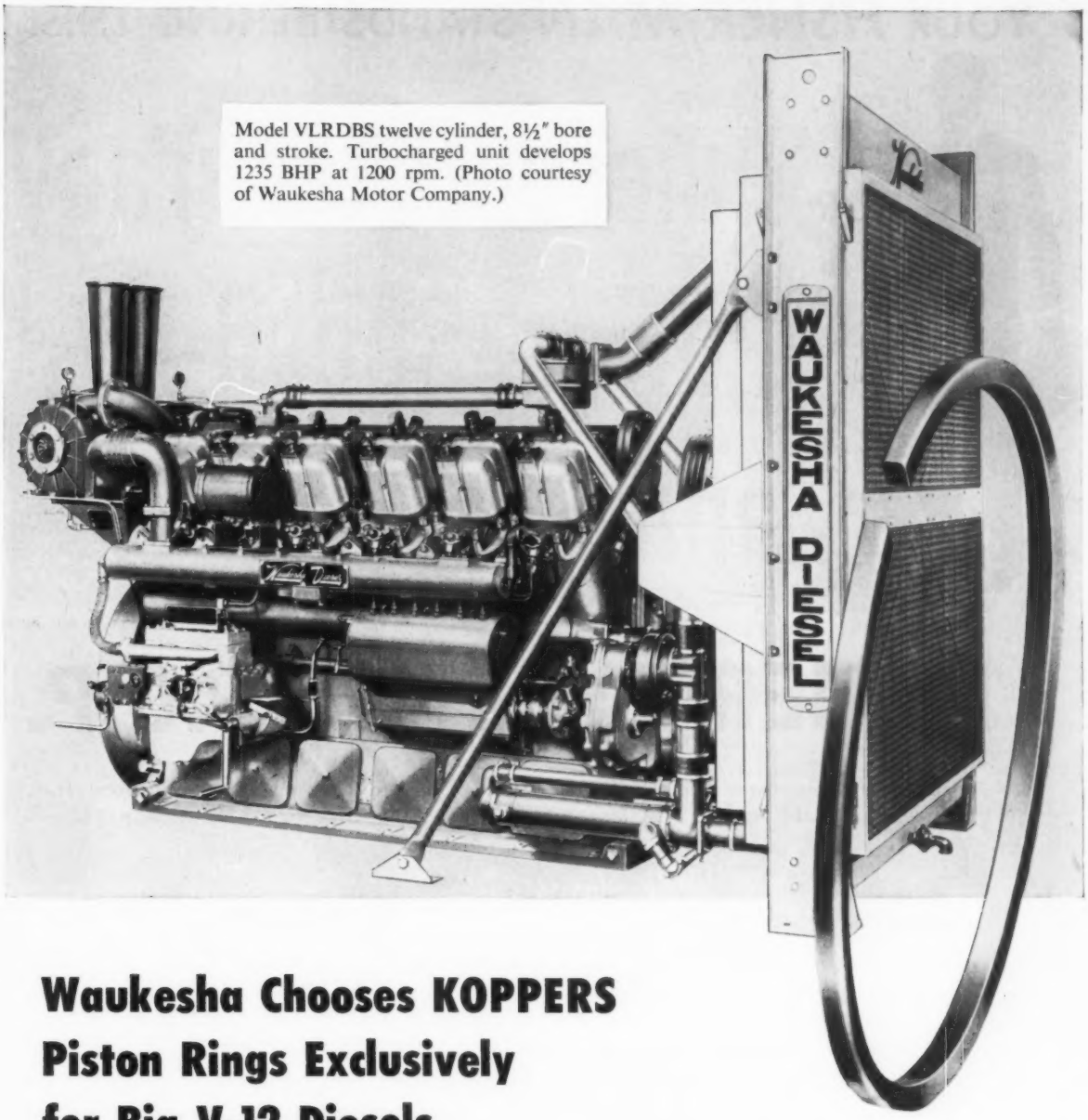


4 Vertical type unit for a hydrogen plant.



5 This steam generator was shipped to a leading overseas petroleum refinery.

Vogt HEAT TRANSFER EQUIPMENT



Model VLRDBS twelve cylinder, 8½" bore and stroke. Turbocharged unit develops 1235 BHP at 1200 rpm. (Photo courtesy of Waukesha Motor Company.)

Waukesha Chooses KOPPERS Piston Rings Exclusively for Big V-12 Diesels

Waukesha's VLRDBS supercharged diesels are perfectly suited for applications such as oil rigs, excavators and tugboats where a surge of reserve power is essential for emergency and overload demands.

This recent series of diesels manufactured by the Waukesha Motor Company, of Waukesha, Wisconsin, is designed to develop tremendous power under the severest operating conditions . . . the kind of power that puts a premium on piston ring performance. Waukesha has selected Koppers Piston Rings as have other manufacturers who must be certain of reliable component performance.

This dependability is yours when you rely on Koppers with their complete range of materials . . . wide selection of types and sizes . . . rigid quality control and careful inspection. These factors contribute to Koppers unchallenged leadership in producing the finest piston and sealing rings for industry.

Instead of undergoing needless expense in solving ring problems, take advantage of Koppers experience, research facilities and craftsmanship. Write for information today. KOPPERS COMPANY, INC., Piston Ring and Seal Dept., 4904 Hamburg St., Baltimore 3, Md.

★ **KOPPERS DEPENDABLE RINGS CONTRIBUTE TO WAUKESHA'S RELIABLE PERFORMANCE UNDER THE MOST RUGGED CONDITIONS.**

KOPPERS

AMERICAN HAMMERED
Industrial Piston Rings
Engineered **Products Sold with** ***Service***

YOUR *FISHER/MAN* STANDS BEHIND THIS

FOR **Inherent Accuracy–Power–Speed–and Stability**

FISHER TYPE 470 P.O.P.

- Delivers same power in either direction at any point of the stroke.
- No air set required—utilizes clean, noncorrosive air or gas up to 150 psi.
- Adaptable to virtually all types of valve bodies including Butterfly valves.
- Easily reversible actuator can be changed in the field.

This small, compact, pneumatically operated piston is available in five sizes with yoke sizes to fit any of the Fisher valve bodies including Butterfly valves. P.O.P. acts with high speed. For example, the 8½-inch size gives you 1.5 inches per second stroking speed. Write Fisher Governor for Bulletin E-59.

Type 470 P.O.P. With Fisher Bodies				
Cylinder Size, Inches	Yoke Boss Size, Inches	Valve Body Size, Inches	Stem Size, Inches	Allowable Stem Force, Lbs.
4¾	2⅛	½—1½	⅜	1,500
	2 13/16	2—4	½	*
	3 9/16	5—8	¾	*
6⅛	2 13/16	2—4	½	2,500
	3 9/16	5—8	¾	*
8½	3 9/16	5—8	¾	5,000
10¾	5	10—16	1	8,000
13	5	10—16	1¼	12,000

*Limitation with these stems is dependent upon the maximum force available from each cylinder.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

FISHER GOVERNOR COMPANY

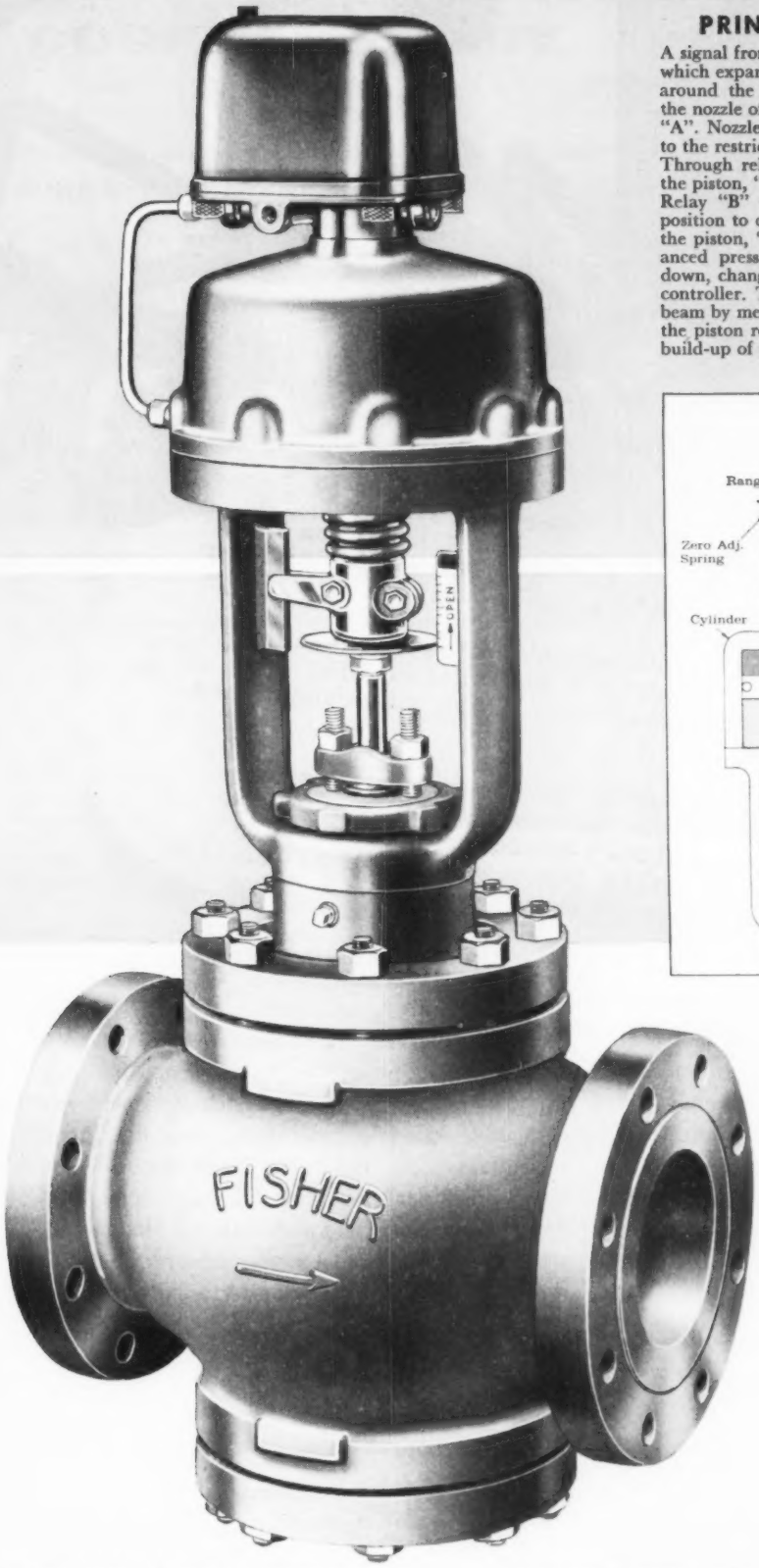
Coraopolis, Pa. / Woodstock, Ontario / London, England

Main Office and Plant: MARSHALLTOWN, IOWA

FISHER® Controls

SINCE 1880

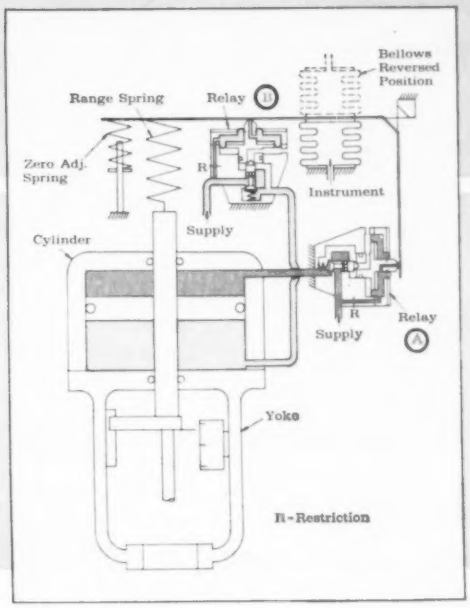
PNEUMATICALLY OPERATED PISTON...



Exterior view of high pressure actuator. Type 470 mounted on a Design "A" body.

PRINCIPLE OF OPERATION

A signal from the controller is received by the bellows which expand to move the beam. The beam will pivot around the fixed point and simultaneously uncover the nozzle of Relay "B" and cover the nozzle of Relay "A". Nozzle pressure will increase in Relay "A" due to the restriction created by the beam over the nozzle. Through relay action, the air pressure to the top of the piston, "A", black in the sketch, will be increased. Relay "B" will be reacting to the change in beam position to decrease the pressure to the under side of the piston, "B", red in the sketch. Due to the unbalanced pressures acting on the piston, it will move down, changing the valve position as dictated by the controller. The piston movement is fed back to the beam by means of a range spring that is connected to the piston rod extension, thus preventing any further build-up of pressure in the cylinder.



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NOT ONE FIELD CUT

in all This

MIDWEST

Shop-Fabricated Piping

...under a subcont...
and I would like to say the West Coast Division have on this job complied fully with the high standards of workmanship for which Midwest is known.

Throughout this entire project not once was a cut necessary to correct any piece of fabrication, and I might add in several instances close tolerances had to be met.

The above was not written on an impulse but as construction superintendent, this means but one thing: fast and low cost erection. Would appreciate your thanking Midwest personally for ...om a construction

Excerpt from letter by:
HOLMES & NARVER • Engineers-Constructors
828 South Figueroa St. • Los Angeles 17

Note particularly the words "*fast and low cost erection*" in the above letter. They characterize Midwest Shop-Fabricated Piping . . . whether for refinery, power plant or industrial installations. In this instance they were written by A. H. Chamberlain, construction superintendent, upon completing the installation of a Houdriformer Unit at the U.S. Oil & Refining Co., Tacoma, Washington.

There are three well-equipped Midwest pipe fabricating shops located to serve economically all sections of the country. Each is staffed by a highly skilled organization using the latest techniques. Each has wide experience on all kinds of projects so that the possibilities and limitations of all piping materials are well understood. You too will find it to your advantage to call in Midwest whenever you need fabricated piping.

MIDWEST PIPING COMPANY, INC.

Main Offices: St. Louis 3, Missouri (P.O. Box 433)
Plants: St. Louis, Clifton, N.J. and Los Angeles

SALES OFFICES:
ASHEVILLE (BOX 446, SKYLAND, N. C.) • ATLANTA 9—72 ELEVENTH ST. N. E. • BOSTON 27—426 FIRST ST. • CHICAGO 3—79 WEST MONROE ST. • CLEVELAND 14—616 ST. CLAIR AVE. • HOUSTON 2—1213 CAPITOL AVE. • LOS ANGELES 33—520 ANDERSON ST. • MIAMI 34—2103 LE JEUNE RD. • NEW YORK 7—50 CHURCH ST. • PITTSBURGH 19, PA.—437 GRANT ST. • ST. LOUIS 4—1450 S. SECOND ST. SAN FRANCISCO 11—420 MARKET ST. • TULSA—1640 E. 21ST ST.

8033

COOPER ALLOY VALVE BRIEFS

THE VALVE AND FITTINGS ANSWER CORNER

Send in your questions on stainless valves and fittings to Carl Tylka, Cooper Alloy Technical Service Director.

Q. *What is meant by "ferroxyl quality" in evaluation of a stainless casting?*

A. This means a superior surface quality free from pinholes, porosity, scale particles, iron film, grease, or other undesirable conditions, as is guaranteed by passing the ferroxyl test.

Q. *Will stainless steel of the 18-8 type corrode in a moist atmosphere?*

A. Not ordinarily, but it will in contact with graphite.

Q. *Can the use of stainless materials having different hardnesses be effective in preventing galling?*

A. Yes, providing the hardness differential amounts to 50 Brinell or more. Corrosion resistance of the hardened material is generally lowered, however, and trouble may ensue in severe service. Use of V2B alloy as the hardened medium will prevent galling and provide sufficient corrosion resistance.

Q. *Is 18-8s MO (316) better than 18-8s (304) for use in hot strong nitric acid?*

A. No, in this particular case 304 is better than 316.

Q. *Why is it that steel is resistant to 70% sulfuric acid, while stainless 304 is not?*

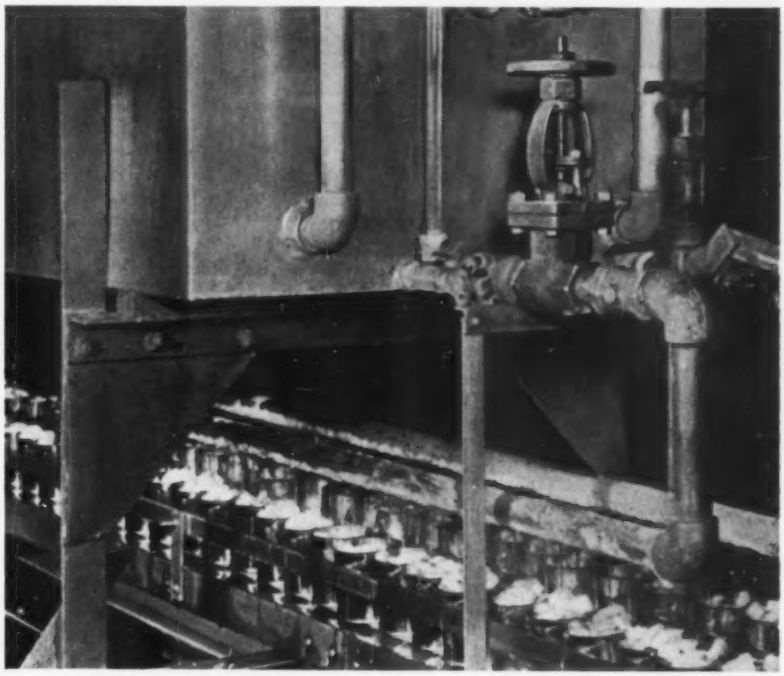
A. Because sulfuric acid forms an iron sulfate film on carbon steel which is insoluble in sulfuric acid of over 65% concentration, thus protecting the steel from further corrosion. This particular film does not form on stainless, which depends upon passivity for corrosion resistance. In 70% sulfuric acid passivity is lost and the stainless corrodes.

Q. *Is 316 alloy better than 304 for handling hot caustic solutions?*

A. No, 316 has no better resistance than 304 and FA-20. That is why Monel is recommended. In extremely severe cases use pure nickel.

Q. *What can I use where 316 is necessary for corrosion resistance, but fails through lack of resistance to accompanying abrasion or erosion?*

A. Cooper PH-55A alloy resists all corrosive media that can be handled by 316 (except very hot and strong nitric acid), and in addition is resistant to both abrasion and erosion.



How the Cooper Alloy Valve became a Giant—among Shrimps!

Cooper Alloy Valve Handles Hot Brine at Shrimp Canning Plant for Twelve Years Without Maintenance

It's not often that we get a chance to put a title as catchy as this on our valve success stories, but this story really rates it!

It all happened at the Robinson Canning Company in New Orleans, one of the world's largest canners of shrimp. They can as much as 100,000 lbs. of shrimp a day—three cans a second! And here's the problem: to the shrimp in each of these cans hot brine solution (180°F.) is added as a preservative—to the shrimps, that is, because brine is mightily corrosive to most valve materials.

The master control valve for this gravity-feed brine-filling operation used to be a brass gate valve, but it couldn't stand the corrosion gaff. So, 12 years ago the Robinson people replaced it with a Cooper Alloy 1-in. Monel gate valve. (Vital statistics: OS&Y, 150-lb. service, bolted bonnet, screwed ends.)

And during the ensuing 12-year period, this Cooper Alloy valve has handled 2500 gallons of hot brine per day—without maintenance of any kind! Only very recently did it become necessary to replace a few non-Monel parts, such as handwheel, packing flange, and eyebolts.

As we said at the start of the story, that's a performance record that's a giant in any man's process! For more information on Cooper Alloy valves and their performance capabilities, write to Cooper Alloy Corporation, Hillside, N. J.

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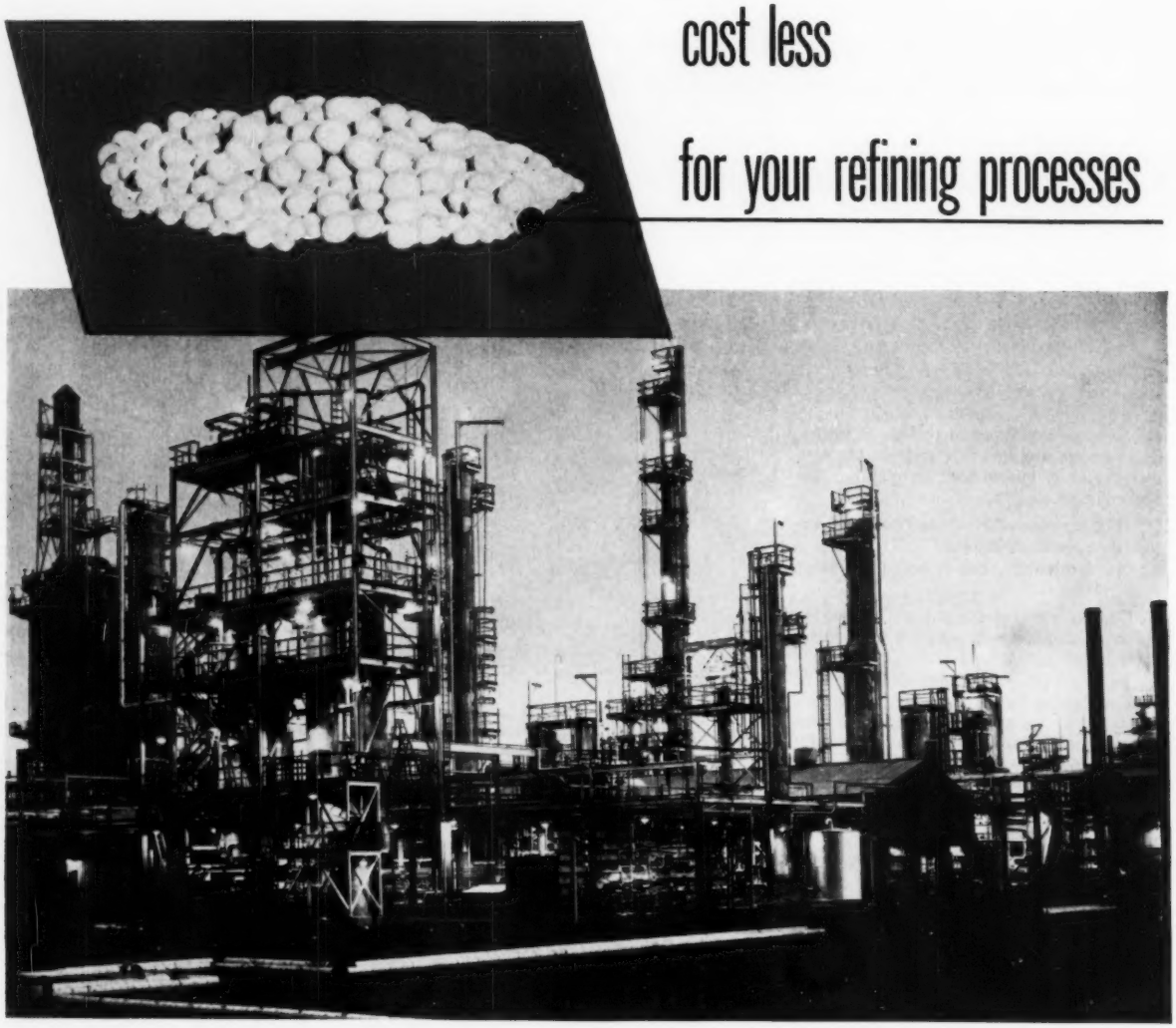
"Shamva" mullite pellets

cost less

for your refining processes



Chemically inert, tough, "Shamva" Mullite pellets have seen commercial service in major refineries for over two years in several types of fixed bed catalytic reforming processes.

Used as inert supports for the active catalyst in fixed bed convertors, "Shamva" pellets take heat shock and pressures without breakage or dusting. They resist abrasion, erosion and crushing, thus do not contaminate valuable catalysts.

SIZES: ½"-⅞", ½"-¾", ⅝"-⅞", ¼"-⅜", and ½"-⅜".

PHYSICAL PROPERTIES:

PCE	Cone 39
Apparent Porosity	10.7%
Bulk Density	163.8 Lbs./cu. ft.
Apparent Specific Gravity	2.94
Packed Density	95-100 Lbs./cu. ft.

Chemical analysis, price and other details are available upon request. Write.

REFRACTORIES DIVISION PORTER **H.K. PORTER COMPANY, INC.**

DIVISIONS: Connors Steel, Delta-Star Electric, Disston, Forge & Fittings, Leschen Wire Rope, Mouldings, National Electric, Refractories, Riverside-Alloy Metal, Thermoid, Vulcan-Kidd Steel, H. K. Porter Company (Canada) Ltd.

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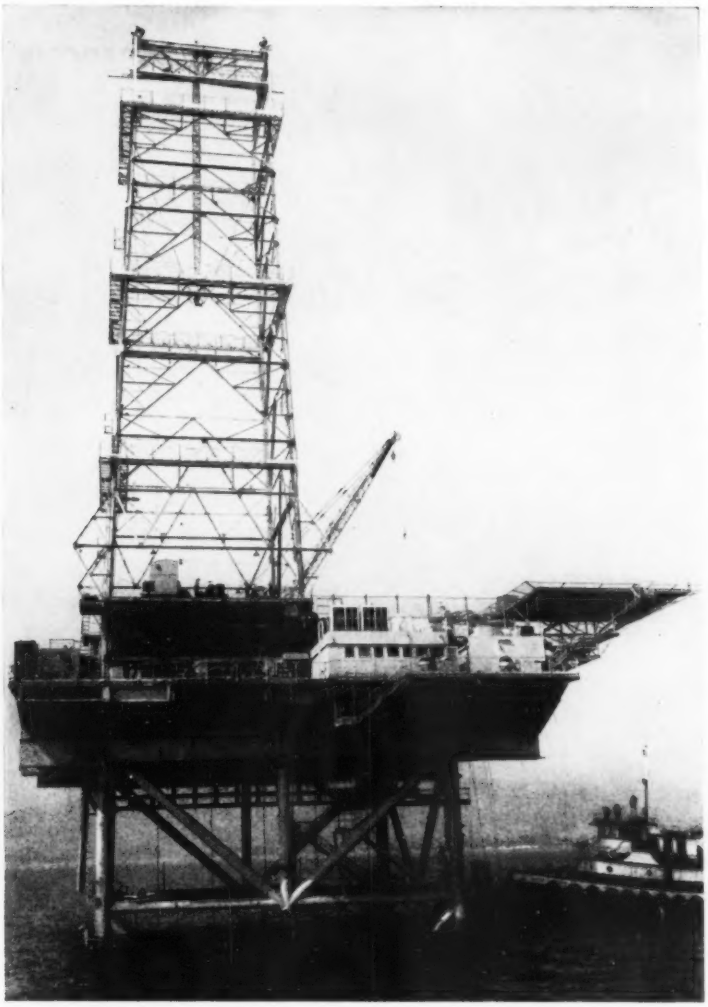
This offshore rig stands in the

WORLD'S LARGEST ELECTROLYTE



Standard Oil Company of California, operator of Standard-Humble Summerland State No. 1, uses proven Amercoat protective coatings to prolong the life of its new offshore rig off Santa Barbara. You will find them on all surfaces above elevation 8'10" MLLW, including the movable fender, boat landing, walking surfaces, gratings, hand rails, stair treads, ladders, ladder cages, water tanks.

The Pacific is terrific—for boaters and bathers. But plant an unprotected steel structure in it, and the world's largest electrolyte begins its attack. In a short time, spray, mist and wave action reduce steel surfaces to the status of a spent battery plate.

Such will not be the fate of California's first permanent offshore drilling rig because modern protective coatings completely shield all steel above the water line from moisture and sea atmosphere.

A permanent base coat of Dimetcote, the inorganic zinc silicate coating, armors all vulnerable surfaces with a tough zinc film that bonds chemically and physically to the steel. If minor abrasions occur, the zinc also doubles as a sacrificial anode to prevent corrosion of the exposed metal. As further defense against the sea, the Dimetcote is covered with Amercoat protective vinyl coatings which add chemical resistance and film thickness.

Will this Amercoat protective coating system stand up against the ravages of the Pacific? It should, for it has performed successfully on scores of offshore rigs, barges and related equipment operating in the Gulf of Mexico and other salt water bodies.

Next time you have a project involving seagoing steel, why not discuss protective coatings with us? Our decades of experience and thousands of case histories may save you time and money in your planning.

For detailed information, technical data and assistance with your marine corrosion problems, write to any of the Amercoat offices listed below:

115

Dept. VD
4809 Firestone Boulevard
South Gate, California

- **921 Pitner Avenue, Evanston, Illinois**
- **2404 Dennis Street, Jacksonville, Florida**
- **360 Carnegie Avenue, Kenilworth, New Jersey**
- **6530 Supply Row, Houston, Texas**

Amercoat® CORPORATION

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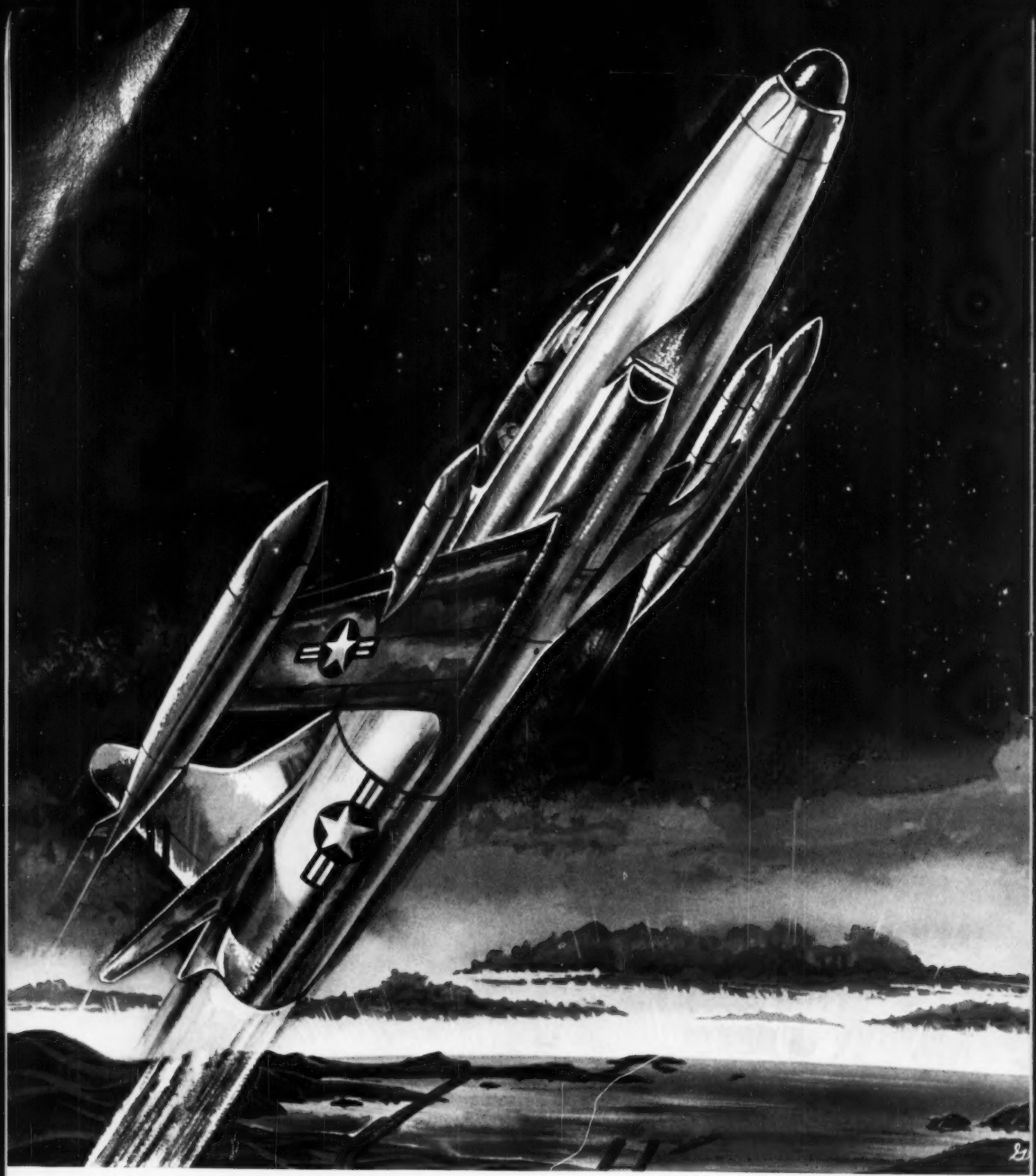


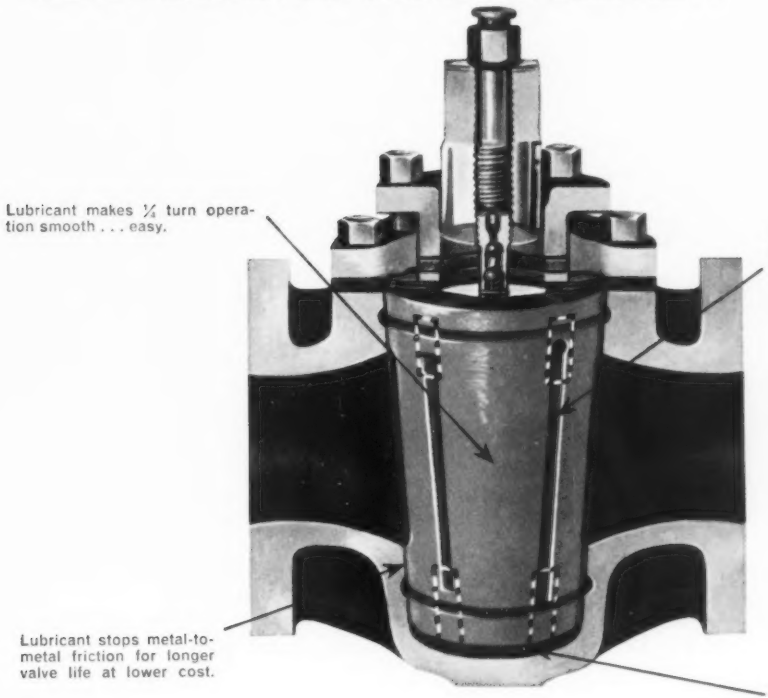
ROCKWELL- Nordstrom **VALVES**

How long would it fly without lubrication?

A sleek jet would be turned into a smoking, grotesque mass of junk *in seconds* without the proper lubrication to prevent metal-to-metal friction.

It's just common sense that wherever metal works against metal, lubrication is an investment in longer life, better performance. That's why Rockwell-Nordstrom *lubricated* plug valves stay in service longer at far lower cost than ordinary valves. But *pressurized lubrication* serves another very important function in these valves . . . it assures positively leak-proof flow control.

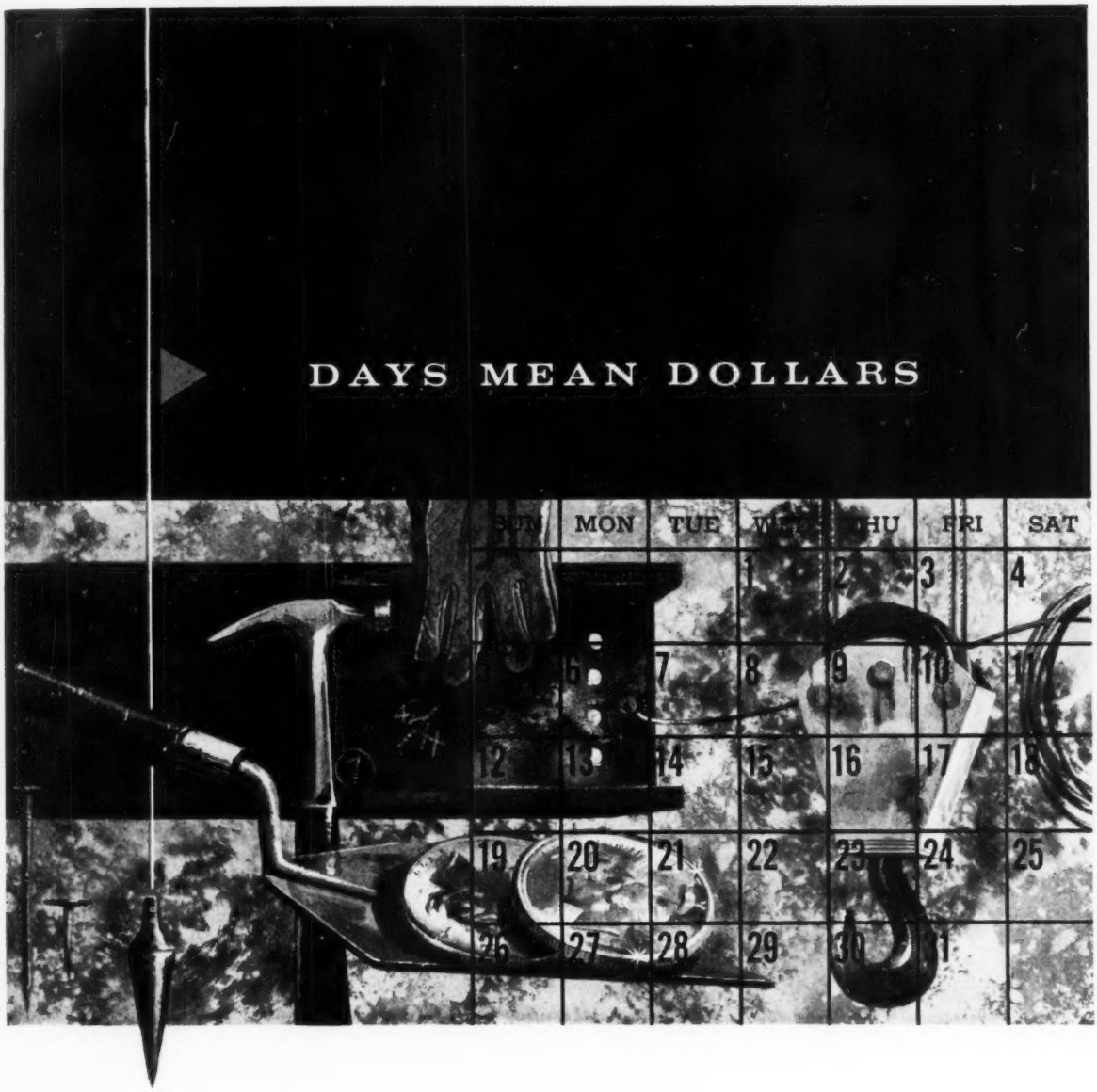
VALVE LUBRICATION MEANS DEPENDABILITY


Lubricant makes ¼ turn operation smooth . . . easy.
Pressurized lubricant in Sealdport® sealing grooves stops leakage of even lightest gases.
Lubricant stops metal-to-metal friction for longer valve life at lower cost.
Pressurized lubricant "cushions" plug for instant operation.

Rockwell-Nordstrom is the original and world's most complete line of lubricated plug valves with sizes from ¾" to 36" and pressures to 15,000 lb. Available at leading oil field and industrial supply houses everywhere. For details, see your supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. If you live outside the U. S. A., write: Rockwell International Division, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES
another fine product by
ROCKWELL

®Reg. T.M. Rockwell Manufacturing Company



Early completion means money saved, more money earned by getting on the line ahead of schedule. This is a big reason why Brown & Root clients come back again and again, through the years.

BROWN & ROOT, INC.

Engineers and Constructors

Post Office Box 3, Houston 1, Texas

Brown & Root, S. A., Panama City, Panama
No. One Wall Street, New York 5, New York
P. O. Box 4140, South Station, Edmonton, Alberta
Pennsylvania Building, Washington, D. C.
Brown & Root Construcciones, S. A., Caracas, Venezuela
Brown & Root de Mexico, S. A. de C. V., Mexico City, Mexico
Brown & Root, LTDA., Santos, Sao Paulo, Brazil
CABLE ADDRESS – BROWNBILT

For more data on advertised products, use Readers' Service Cards, last page.

what's the secret

why is Caposite so strong?

It's no secret why CAPOSITE insulation is so strong and stands up to such rough usage. These pipe sections and blocks are made wholly of Amosite asbestos and the long fibres of this particular kind of asbestos give CAPOSITE its strength and resilience as well as its high insulating value. This exceptional strength leads to many other features besides long life; it means that larger sizes of pipe sections and blocks are possible, making application easier and faster. Less care is needed in handling the material. Unlike other moulded insulation, CAPOSITE, because of its strength, can be shipped to refineries anywhere in the world *in cardboard cartons*, showing big savings in freight and storage costs.

CAPOSITE Regd.

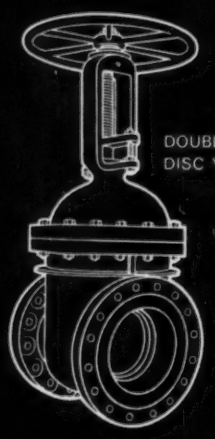
ASBESTOS INSULATION

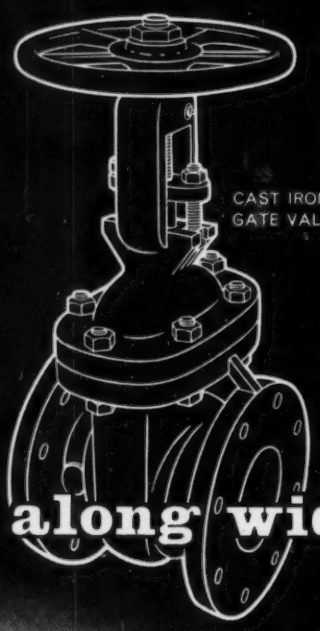
THE CAPE ASBESTOS COMPANY LIMITED, 114 & 116 PARK STREET, LONDON W1 Tel: Grosvenor 6022 Cables: Incorrupt London

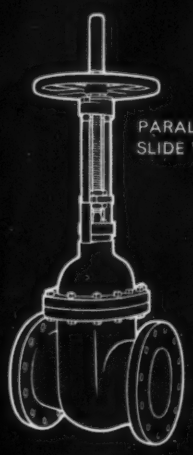
Enquiries in Canada to: Cape Asbestos (Canada) Limited, 200 Bloor Street East, Toronto, Ontario
U.S.A.: North American Asbestos Corporation, Board of Trade Building, Chicago 4, Illinois

TA 10642

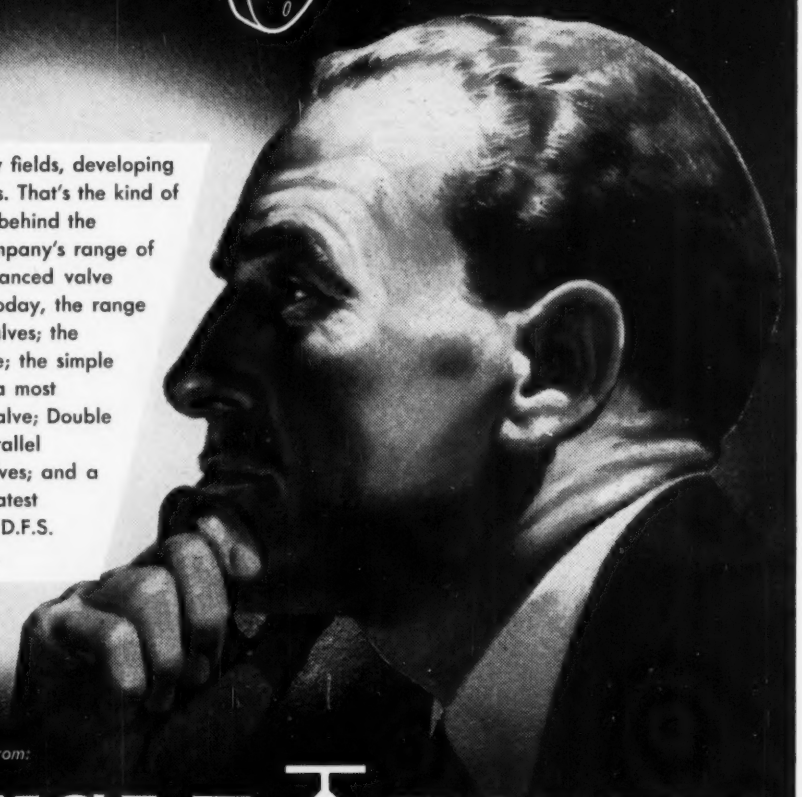
For more data on advertised products, use Readers' Service Cards, last page.







Thinking along wider lines . . .



. . . entering new fields, developing new ideas. That's the kind of look-ahead thinking behind the Triangle Valve Company's range of some of the most advanced valve designs available. Today, the range includes Alloy Steel Valves; the Cast Iron Gate Valve; the simple action Line Blind Valve; a most efficient Wellhead Valve; Double Disc C.S. Pipeline and Parallel Slide C.S. Steam Valves; and a whole series of the latest design pipe fittings in D.F.S. and malleable iron.

Full technical details and specifications from:

TRIANGLE VALVE CO. LTD.

CANBERRA HOUSE, 315-7 REGENT ST. W.1.

Tel: LANGHAM 6526-7-8 Cables: Trivalon London Telex 24-100 Works: Lamberhead Green, Wigan, Lancs, England

Agents in: Holland · Belgium · Italy · W. Germany · Canada · Australia · Pakistan · Eire · Venezuela · France · Poland · Sweden · Finland · Norway

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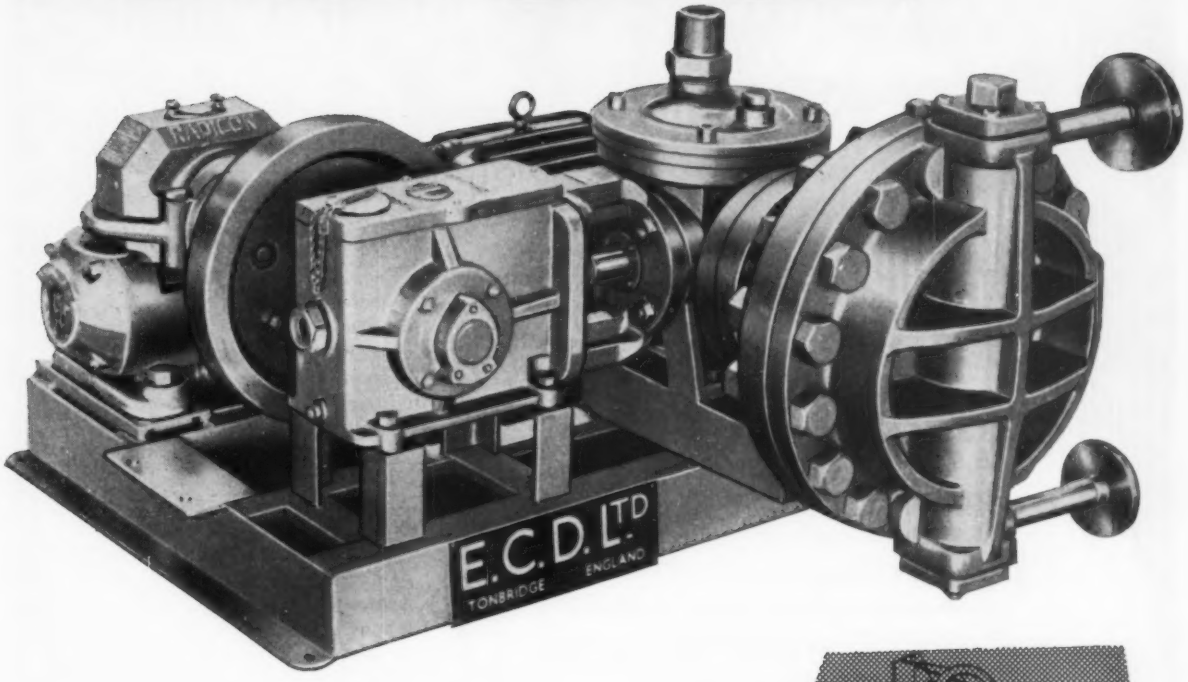
Automation comes to the Refinery

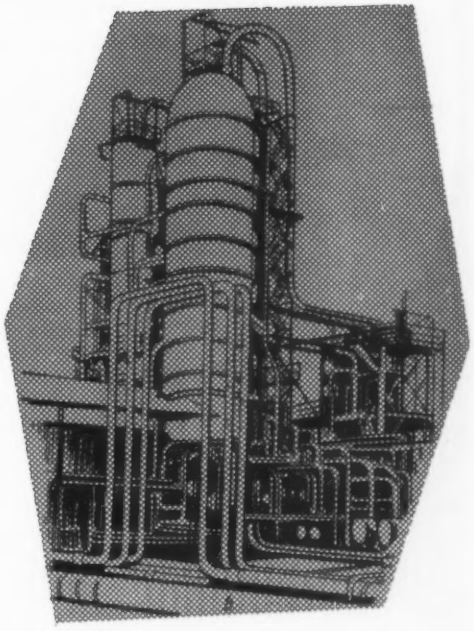


Piston-operated Diaphragm Pump

E.C.D. Hydraulically operated Diaphragm Pumps can be supplied also in battery assemblies—each pump fitted with individual micro capacity control. In assemblies, the pumps are driven by one power unit, and the speed of the complete assembly can be varied from zero to full by a signal pressure of from 3. lbs. to 15. lb. per square inch.

The rate of delivery of any mixture is automatically controlled from the process plant.

E.C.D. Pumps are in constant use throughout the world—call in our technical staff for consultation.



E.C.D. LIMITED • ENGINEERS

TONBRIDGE · KENT · ENGLAND

Telephone: TONBRIDGE 2237 (3 lines) Telegrams: TONMIL, TONBRIDGE.

One of the Wallace & Tiernan Group of Companies

For more data on advertised products, use Readers' Service Cards, last page.

KETJEN
AMSTERDAM

ARE SERVING THE OIL INDUSTRY

- **KETJENCAT**
  M.S. Fluid Cracking Catalyst
- **KETJENFORM**
  M.S. Fluid Hydroforming Catalyst
- **KETJENFINE**
  Hydro-desulphurisation Catalyst

CK 103/106 Platinum Reforming Catalyst

CYANAMID KETJEN

In August 1958 Cyanamid-Ketjen N.V. started production of platinum reforming catalysts. These fully regenerative platinum catalysts give outstanding performance in upgrading low octane gasolines to high value motorgasoline components in catalytic reforming units.

"X" Catalysts

Improvements of the above-mentioned catalysts are the objective of our research efforts and are carried out in our well-equipped laboratories and pilot plant facilities.

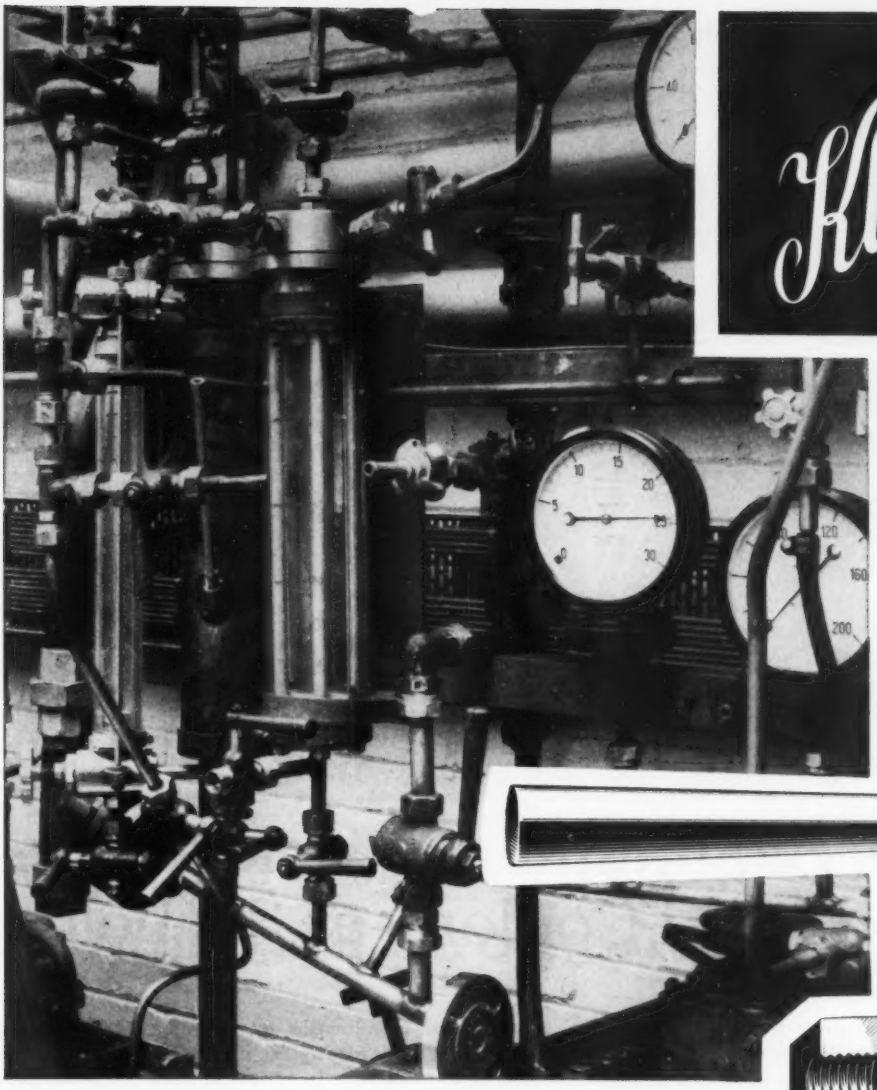
A more efficient use of fresh m.s. catalyst in fluid catalytic cracking operation is provided by the continuous addition and measuring system, developed and patented by Ketjen. The essential parts of this system, the KETJEN FEEDING and KETJEN WEIGHING DEVICE, can be made available to refineries. At Ketjen's works in Amsterdam a special laboratory is available to all refineries for testing fresh and used catalysts.

In our stand at the Exhibition in the Coliseum in New-York during the World Petroleum Congress our managers and technicians will be in attendance to give any assistance or information on request.

NV CP

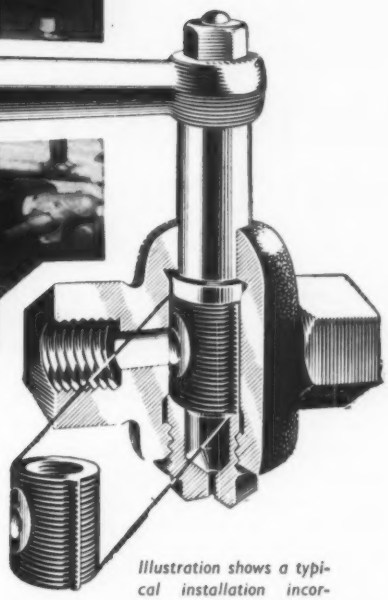
The sale of catalysts and other Ketjen products is being handled by
NEDERLANDSCH VERKOOPKANTOOR VOOR CHEMISCHE PRODUCTEN N.V.
63 Mauritskade, Amsterdam - Holland. P.O.B. 4038. Telephone 54322. Telex 12270. Telegrams: Chemicals

KJ-4-20 E



Klinger

SLEEVE-PACKED COCKS



In the last quarter of a century Klinger Sleeve-Packed Cocks have steadily replaced the old-fashioned asbestos-packed cocks with their limitations of working pressure, difficulty of repacking and tendency to jam. They are available in a wide range of designs and sizes for all purposes and pressures, and with the following advantages:

- **Renewable "Klingerit" packing sleeve.**
- **Re-tightening during use.**
- **Parallel-ground non-jam plug.**
- **Unobstructed straight-thru full-bore passage.**

Illustration shows a typical installation incorporating Klinger Sleeve-Packed Cocks, at a famous research establishment.

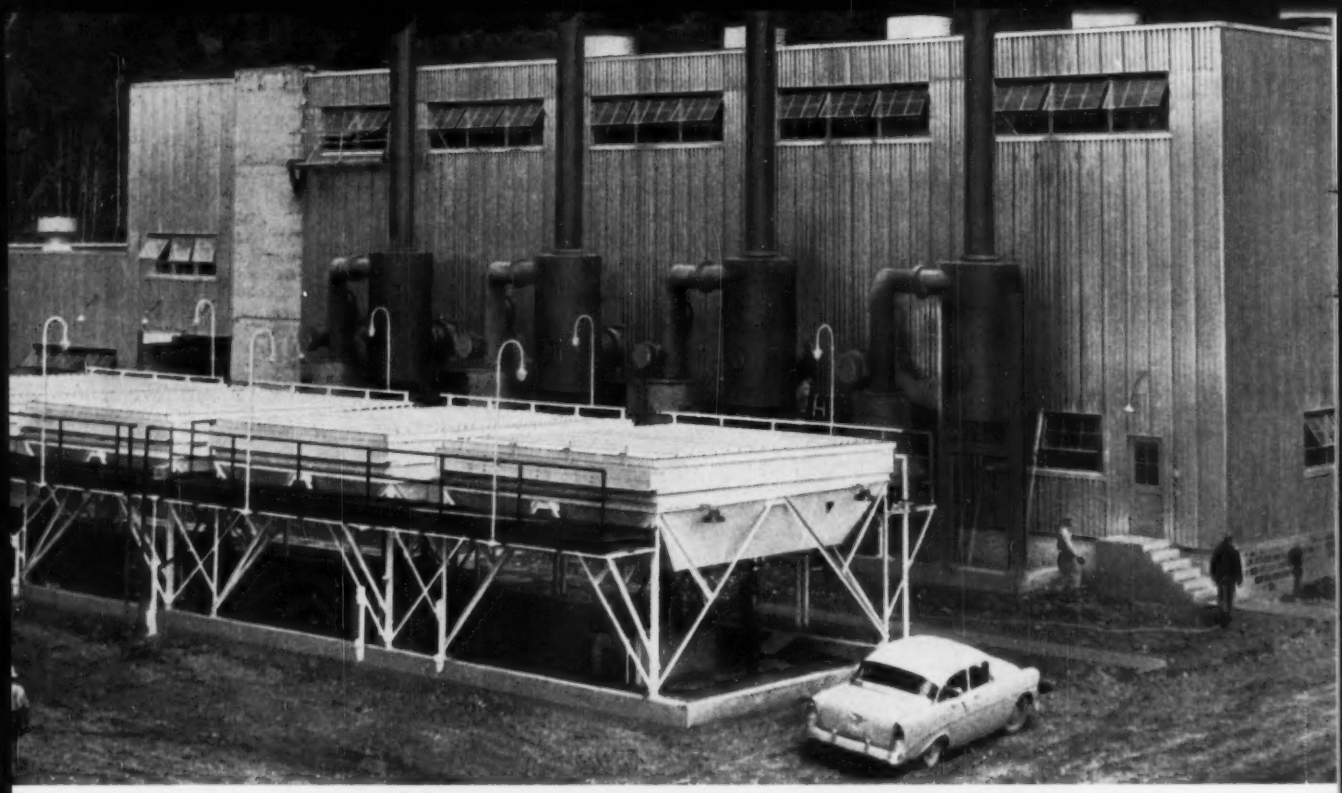
THE KLINGER CORPORATION OF AMERICA, 95 RIVER STREET, HOBOKEN, NEW JERSEY.
Telephone: Oldfield 6-1300

Manufacturing Licensees for Canada

JOSEPH ROBB & COMPANY LIMITED, 5575, COTE ST. PAUL ROAD, MONTREAL, 20, CANADA
Telephone : GLENVIEW 9151
Branches at: SYDNEY, HALIFAX, OTTAWA, TORONTO, HAMILTON, WINNIPEG, EDMONTON, VANCOUVER, QUEBEC CITY

RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND.

GA42/58/C



Twenty air cooled units like this cool engine jacket water for four Canadian "Big Inch" compressor stations. Units are designed to dissipate 8.6 MBTU/hr. from the 288 gpm jacket cooling water at temperatures from 170 to 110° with an ambient temperature of 90° F. General contractor: Canadian Bechtel, Ltd.

Canadian "Big Inch" cools jacket water with Trane Fluid Coolers - at 35° below!

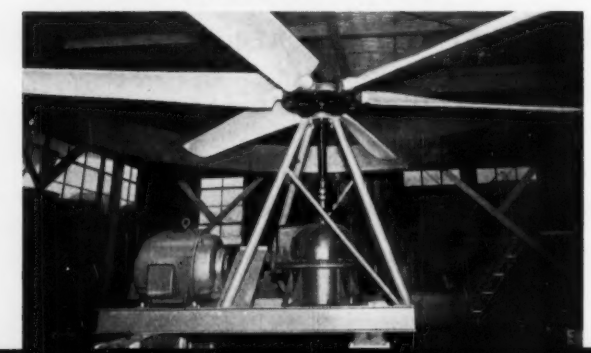
Westcoast Transmission Company's 650 mile-long, 30-inch pipeline system through British Columbia passes through country where winter temperatures are very low. Cooling engine jacket water for compressor stations along the way takes rugged equipment—coolers that can function efficiently at 35 or 40 degrees below zero.

Westcoast Transmission Company chose TRANE Fluid Coolers for this important job. Air cooling was essential at these extreme temperatures. And TRANE Fluid Coolers have shown that they meet exacting requirements under all weather conditions.

More and more major transmission companies are turning to TRANE for rugged, dependable Fluid Coolers. Many of these companies report simplified maintenance, a minimum of adjustment problems. And, with TRANE Fluid Coolers, engineers know that they can depend upon the accuracy and completeness of the capacity ratings—based upon the industry's most complete laboratory testing.

When you have a fluid cooling problem, turn to TRANE! Call your nearby TRANE Sales Office. Or write TRANE, La Crosse, Wisconsin.

The air handling segments have shutters for control of their forced vertical air flow, with variable-pitch propellers. (TRANE Fluid Coolers are also available with horizontal discharge.) 2-speed fan, motor and drive are factory-aligned on a single metal base. All framework parts are predrilled and match-marked.



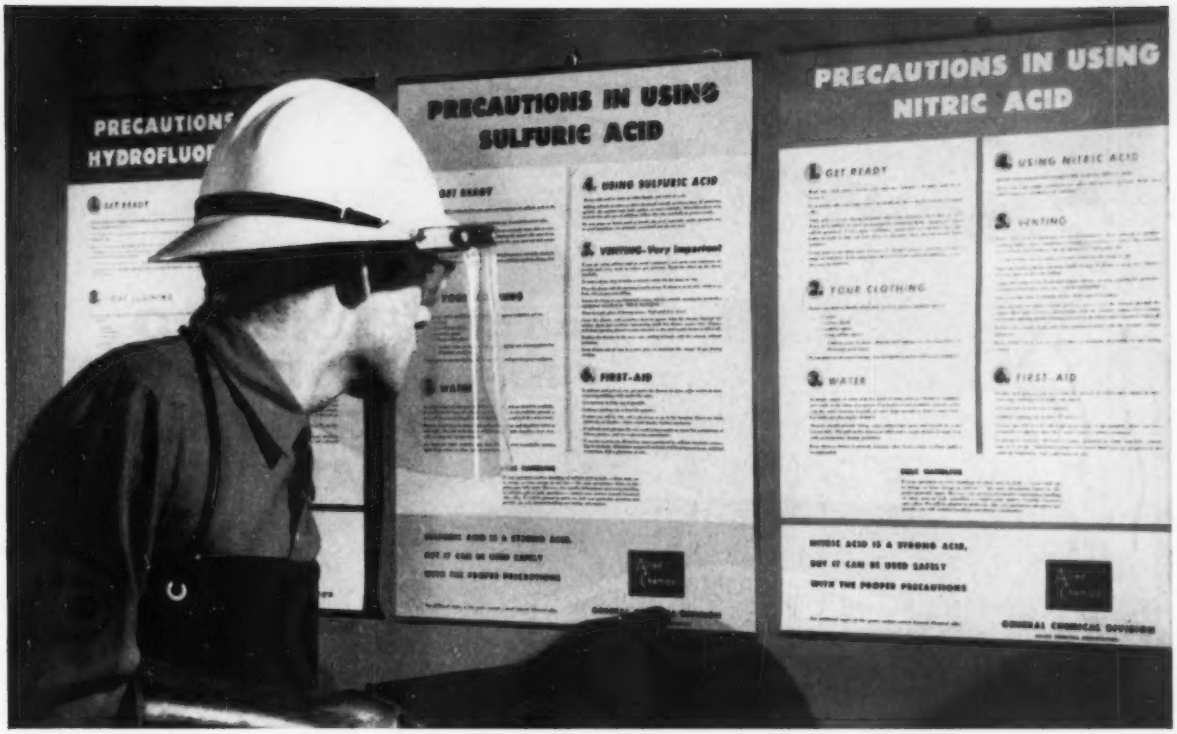
For <u>any</u> air condition, turn to

TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 100 U.S. AND 19 CANADIAN OFFICES

Now Available from General Chemical...



3 New Safety Posters on the Proper Handling of Strong Acids

SULFURIC
HYDROFLUORIC
NITRIC

Here's essential information on how to handle sulfuric, hydrofluoric and nitric acids safely . . . from the people who know them best.

As the nation's leading producer of these strong acids, General Chemical now offers 3 safety posters which spell out the precautions that *must* be taken when handling sulfuric, hydrofluoric or nitric acid. The posters contain such important information as: the proper clothing to wear and the equipment to use; the use of water as a neutralizer; the importance of venting; first aid, and many other necessary precautions.

The posters are free. They are large and easy to read—17 inches wide by 22 inches long. They come complete with metal rims, top and bottom, ready to post in a prominent position in your plant. To obtain any or all three, mail the coupon.

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

Mail Coupon for Posters!

GENERAL CHEMICAL DIVISION PR-49
ALLIED CHEMICAL CORPORATION
40 Rector Street, New York 6, N. Y.

Please send your free safety posters checked below.

- ☐ Precautions In Using Sulfuric Acid
- ☐ Precautions In Using Hydrofluoric Acid
- ☐ Precautions In Using Nitric Acid

Name_____

Title_____

Company_____

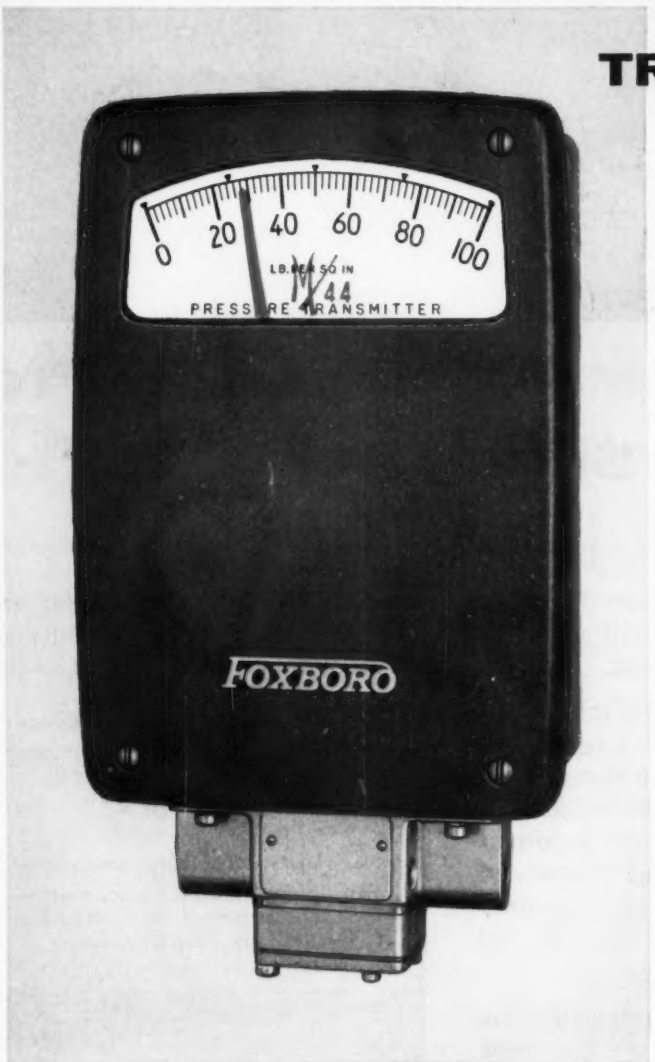
Address_____

City_____ Zone____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

read pressure up to 20 ft. away!

on the FOXBORO M/44 INDICATING PRESSURE TRANSMITTER



You can check pressure readings at a glance on the Foxboro Pneumatic Indicating Pressure Transmitter. Its open-face, horizontal, 4-inch indicator scale and eye-catching red pointer are clearly visible as far away as 20 feet.

But high readability is just part of the story. Actually, this instrument was engineered from the ground up. Makeshift arrangements have been eliminated, hung-on gauges are gone. Everything is included in one compact (5¾" x 8⅛"), ready-to-install instrument that weighs only eight pounds.

Because the indicating pointer is direct-connected to element and transmitter, calibration is easy . . . and you can re-zero the transmitter externally. All M/44 components are standard, performance-proved Foxboro parts. This makes it easier to stock and service.

A wide selection of interchangeable Foxboro pressure measuring elements gives the M/44 range limits of 0-30" water to 0-6000 psi. Elevated ranges are available, too.

Write for complete details. **The Foxboro Company, 744 Norfolk St., Foxboro, Mass.**

FOXBORO
REG. U.S. PAT. OFF.

INSTRUMENTATION FOR INDUSTRY

For more data on advertised products, use Readers' Service Cards, last page.

These 46 Sola-Flex® distributors can serve you anywhere . . . faster!

WHEREVER YOU ARE LOCATED in the United States there is a dependable Sola-Flex representative nearby—ready to give immediate service and technical assistance on your expansion joint needs. This prompt, efficient service is but one of the many reasons why forty of America's fifty largest businesses rely on Sola-Flex expansion joints to help solve difficult piping problems. (Another reason is the outstanding Sola-Flex record of performance and reliability.)

Solar manufactures the most comprehensive line of expansion joints in the world. They are made from a wide variety of stainless and high-temperature alloys in a complete range of sizes from ½ in. to 35 ft in diameter. Temperatures range from −320F to 1200F, pressures from full vacuum to 600 psi and up. *And rugged Sola-Flex expansion joints can be "in service" one to four weeks after receipt of order.*

A new pamphlet describes Solar's complete line of Sola-Flex expansion joints. Write for it to Dept. F-140, Solar Aircraft Company, San Diego 12, California.

SOLAR AIRCRAFT COMPANY — SAN DIEGO, DES MOINES

ALBANY, N.Y.—Energy Control Co., Inc. 1203 Central Avenue
ATLANTA, GA.—Control Equipment Co., Inc. Rm. 130—3166 Maple Drive NE
BALTIMORE, MD.—Energy Control Corporation 2127 Maryland Avenue
BIRMINGHAM, ALA.—Control Equipment Co., Inc. 1929 Shades Crest Road
BOSTON, MASS.—T. F. Fitzgerald 201 Devonshire Street
BUFFALO, N.Y.—Bass Industrial Equipment Co. 6045 Main Street
CHARLOTTE, N.C.—Mechanical Equipment Co. P. O. Box 4066
CHICAGO, ILL.—Piepenbrink & Schoonhoven 53 W. Jackson Blvd.
CINCINNATI, OHIO—Albert A. Azar & Associates 1987 Connecticut Avenue
CLEVELAND, OHIO—F. F. Eiseman 627 Hanna Building
CORAL GABLES, FLA.—Pan Amer. Western Co., Inc. 2103 Le Jeune Road
DALLAS, TEXAS—Power Specialty Co. 4512 N. Central Expressway
DAVENPORT, IOWA—DECO Engineering 320 Western Avenue
DENVER, COLO.—Hank Thurstin Co. 475 Acoma Street
DES MOINES, IOWA—DECO Engineering 1112 Locust Street
DETROIT, MICH.—A. J. Blecki 408 Donovan Building
EL PASO, TEXAS—George S. Thomson Co. 611 N. Campbell Street
GREENSBORO, N.C.—Mechanical Equipment Co. P. O. Box 965
GREENVILLE, S. C.—Mechanical Equipment Co. P. O. Box 1571
HOUSTON, TEXAS—Power Specialty Co. P. O. Box 6365—2000 Kipling
KANSAS CITY, MO.—Condit Co. 638 W. 39th Street
LOS ANGELES, CALIF.—Southport Engineering Co. 235 W. 32nd Street
MEMPHIS, TENN.—T. J. O'Brien Engineering Co. 668 S. Main Street
MINNEAPOLIS, MINN.—Arthur B. Anderson 3336 Hennepin Avenue
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RICHMOND, VA.—H. M. Summerell Co. Suite 105 Seaboard Building
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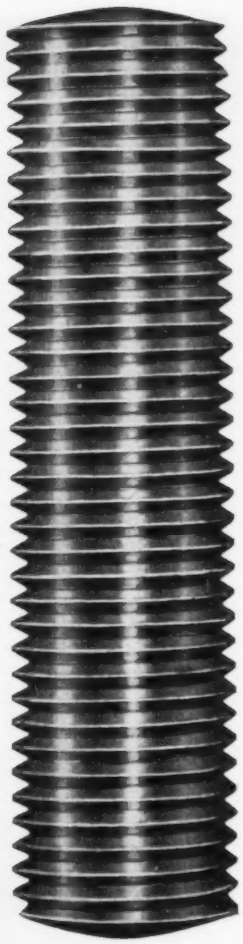
SALT LAKE CITY, UTAH—Pace-Turpin & Co. 726 South Third West
SAN FRANCISCO, CALIF.—Trident Engineering Co. 16 Beale Street
ST. LOUIS, MO.—O'Brien Equipment Co. 2832 Olive Street
TULSA, OKLA.—Condit Co. 1011 S. Main Street
WASHINGTON, GA.—Control Equipment Co., Inc. P. O. Box 565
WILMINGTON, DEL.—Energy Control Corp. 900-A W. 8th Street
BUENOS AIRES, ARGENTINA—Manuel A. Munoz Migueletes 1074
EDMONTON, ALBERTA, CANADA—Alberta Valve Specialties, Inc. 8035 102nd Street
HONOLULU, T.H.—Durant-Irvine Co., Ltd. 450 Piikoi Parkway
TOKYO, JAPAN—Nissho Co., Ltd. Tokyo Boeki Kaikan Bldg. 2, 1-Chome, Otemachi Chiyoka-ku
TORONTO, ONTARIO, CANADA—Bass Industrial Equipment Co., Ltd. 214 Merton Street
VANCOUVER, B.C., CANADA—Fleck Brothers, Ltd. 110 Alexander Street

ENGINEERS WANTED! Challenging projects, unlimited opportunities with Solar. Write today!

For more data on advertised products, use Readers' Service Cards, last page.

There's nothing ordinary about the fasteners illustrated on this page. Bethlehem engineers designed them to resist the high and low temperatures—and the high pressures . . . of refinery bolting. You can depend on them for long life, low maintenance. Full details gladly supplied by our nearest sales office. Or write to us at Bethlehem, Pa.

Bethlehem continuous-thread stud has no point of thread run-out. Stresses can't concentrate at any specific area. Instead, stresses are evenly distributed over the full working length of the stud.



One of these four nuts meets your temperature or pressure requirements. Each meets ASTM Spec. A-194. Each is tapped to Class 2B fit. Each is available in the full size range.

Grade 4, severe temperatures and pressures.

Grade 2H, higher temperatures and pressures.

Grade 2, moderately high temperatures and pressures.

Grade 4L, low temperatures.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

look
what's
new
in

metering pumps

new streamlined safety shield
new crank-type design
new improved accuracy
new parts interchangeability
new operational efficiency
new maintenance ease

all for a new lower price

Send for new booklet giving the biggest news in pumps...

See how the all-new Hills-McCanna Masterline metering pump can bring you new highs in economy and performance. This booklet tells the story . . . gives you the details on the pumps that go new *inside* and *outside* to register all-time highs in accuracy, dependability and maintenance ease.

Ask for Bulletin #900 "Look What's New in Metering Pumps". . . it pinpoints the features that make Masterline pumps your best buy for now and the *future!*

Hills-McCanna Company, 4614 W. Touhy Ave., Chicago 46, Ill.

hills-mccanna company

THE PEOPLE WHO KNOW AND CONTROL FLOW

For more data on advertised products, use Readers' Service Cards, last page.

Now! Ready-to-install in a single package—

- **High-temperature insulation**
- **A protective metal jacket**
- **A built-in vapor barrier**

The insulation in Metal-On is Johns-Manville Thermobestos®... finest of all the calcium silicate insulations for service to 1200°F.

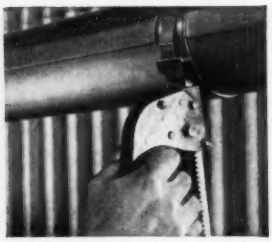
From carton to

...with

Thermobestos calcium silicate insulation

5 SECONDS TO REMOVE Metal-On from carton. Another 25 seconds to snap on pipe and lock in place!

15 SECONDS LATER the specially designed aluminum "snap strap" (containing vapor seal) has been snapped on joint.



METAL BAND provides perfect joint protection against vapor and weather. Total elapsed time: 90 seconds!

Here's the fastest, most efficient way ever to install high-temperature pipe insulation and protective aluminum jacketing.

Metal-On is the insulation idea all industry has asked for: a single package product that permits application of Thermobestos pipe insulation and corrosion-resistant metal jacket in one fast operation. You'll find that a section of Metal-On can be applied as fast as, oftentimes faster than, an insulation alone.

Snaps in place . . . F-A-S-T!

J-M's new Metal-On consists of Thermobestos calcium silicate insu-

Metal-On ends jacket thickness and alloy guesswork! The Metal-On jacket measures an ideal .016-inch thick . . . of a high-quality aluminum alloy selected for superior weather resistance.

pipe in 90 seconds!

new J-M METAL-ON Insulation!

factory-jacketed in gleaming, weatherproof aluminum

lation, a vapor barrier and an all-weather protective covering of aluminum. Furnished ready-to-install, a section of Metal-On snaps on the pipe, locks tightly in place (new locking device is exclusive Metal-On feature) to seal out weather and protect the insulation indefinitely. Joints are sealed tight with aluminum "snap straps" mechanically fastened in place with metal bands.

Right alloy . . . proper thickness

The Metal-On aluminum jacket reduces maintenance in virtually every outdoor pipe application! It never needs painting . . . won't rust . . . is impervious to surface dirt, oils and grime. The jacketing is made of an aluminum alloy (containing magnesium) that is specially selected for superior corrosion resistance. Jacket thickness is designed to provide, at lowest cost, outstanding appearance, stiffness, workability and resistance to abuse and pitting.

Metal-On presents no fitting problem. It is cut easily right on the job with either power or hack saws. Available in 36″ sections in a complete range of pipe sizes through 24″ . . . by 3″ thickness.

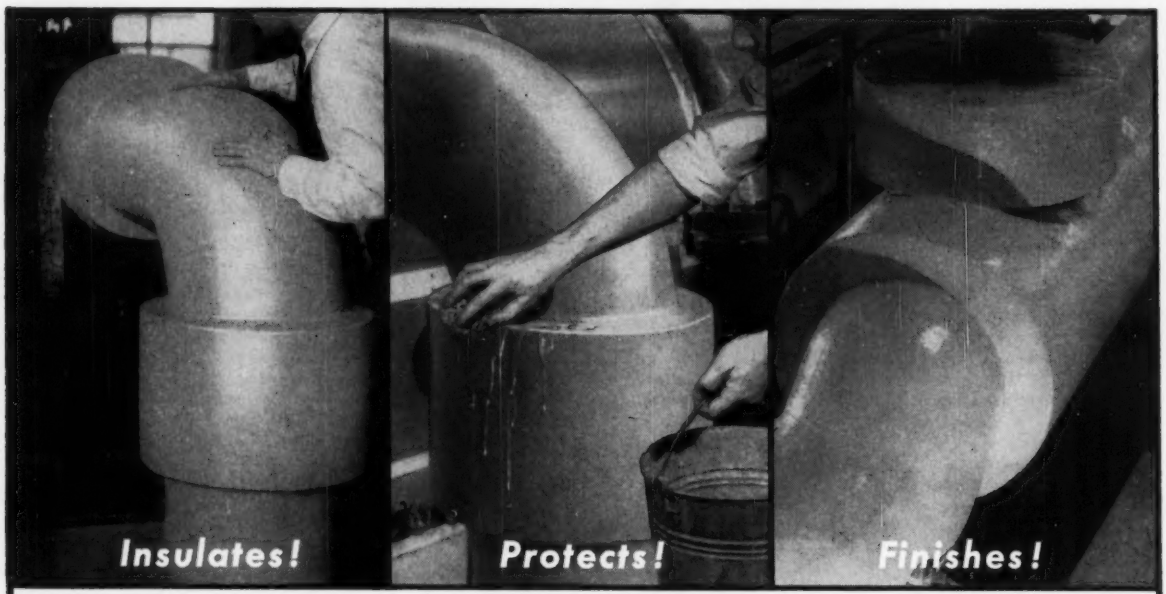
To help you investigate Metal-On for your next pipe insulation requirement, let us send you the informative brochure, IN-217A. Write for it today. Address Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JOHNS-MANVILLE JM PRODUCTS

For more data on advertised products, use Readers' Service Cards, last page.

1 QUICK APPLICATION® INSULATES, PROTECTS, FINISHES!

EAGLE-PICHER
ONE-COTE CEMENT



- Saves time, work, money! One quick application provides smooth, light reflectant surface on hot or cold equipment!
- Clean, easy to handle! Just trowel it on—even on irregular areas where application of other insulations is often impractical.
- Highly efficient! Effective insulation at temperatures up to 1000 F.
- For outdoor installations! Quick-setting, withstands rain and moisture two hours after application. Prevents rust!
- For indoor installations! Requires no wire mesh or finishing treatment!

FREE SAMPLE!
Write today!

Prove to yourself, on your equipment, how Eagle-Picher One-Cote Cement can save you time, money and valuable man-hours.

Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.

Since 1843

EAGLE EP PICHER

EAGLE-PICHER

The Eagle-Picher Company • General Offices: Cincinnati 1, Ohio

(*Member of Industrial Mineral Fiber Institute*)

For more data on advertised products, use Readers' Service Cards, last page.

The care and feeding of the "Chopper" . . .

. . . is one of the many uses for high octane gasoline as America becomes more air-minded.

The production of the blending components of high octane fuel is the principal application of Skelly Oil Company's HF alkylation unit at El Dorado, Kansas, pictured above.

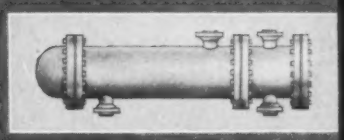
Utilizing dried olefins and isobutane as charges, Skelly employs Western Heat Exchangers as acid-hydrocarbon reactors, thus helping to simplify the unit operations with consequent reductions in both investment and operating expense.

WESTERN

HEAT EXCHANGERS

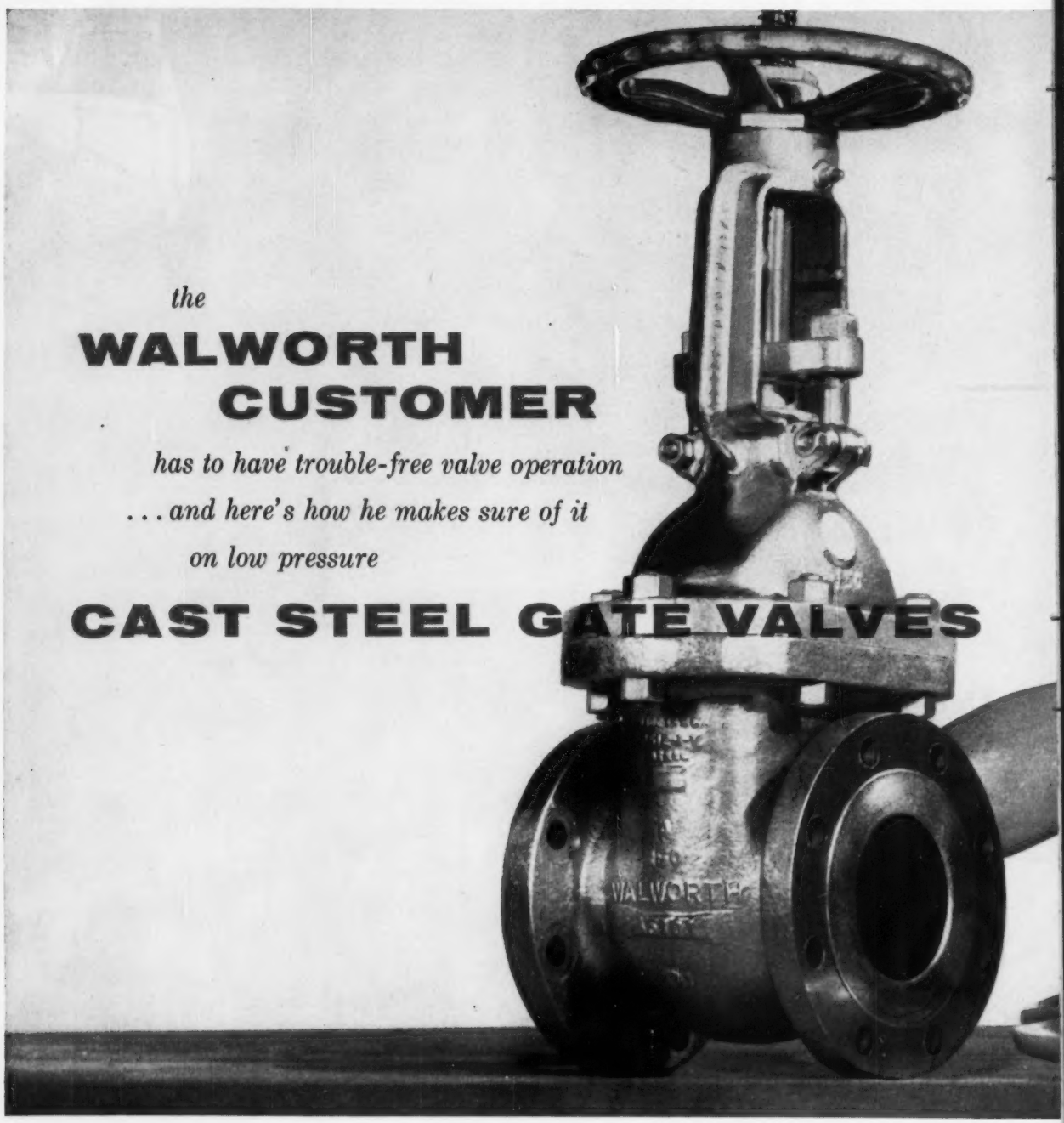
WESTERN SUPPLY COMPANY

P.O. Box 1888 – Tulsa, Oklahoma



Let Western's engineering and design specialists assist in the solution of your heat transfer problem — for greater efficiency and economy.

See Western's Data Pages in the latest edition of Chemical Engineering Catalog.

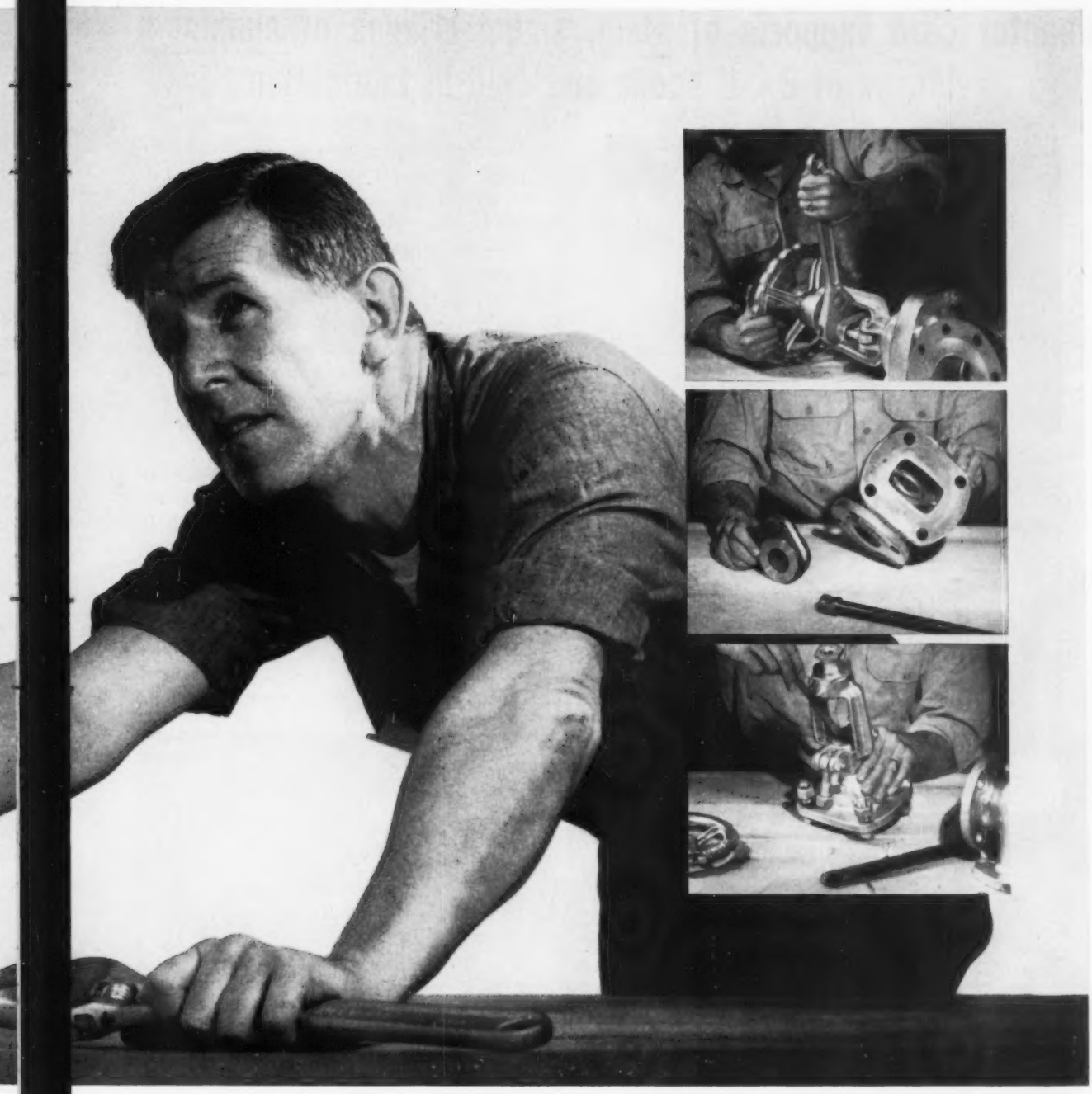


Before the Walworth Customer makes his decision on cast steel valves he gets persistently curious about things like these: What features reduce turbulence and pressure drop? Can body-to-bonnet joint be reassembled in the field without danger of misalignment? Is stuffing box deep enough to assure tightness and maximum life of packing?

In the Walworth Cast Steel Gate Valves he finds streamlined ports to fight turbulence and pressure drop. He finds flat gasket and male-and-female joint closures that assure correct realignment in field or shop reassemblies. He finds stuffing box depth adequate-plus for tightness and packing durability.

It's for customers like this man that

For more data on advertised products, use Readers' Service Cards, last page.



Walworth exists. We know he's hard to please, and we're proud to please him. If his exacting buying standards in valves are yours, too, we'd like you for a Walworth Customer. For details on all types and ratings of Walworth Cast Steel Gate Valves, or any of the complete line of Walworth Valves, contact your Walworth Distributor.

Or write **WALWORTH** *750 Third Avenue, New York 17, N. Y.*

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

WALWORTH SUBSIDIARIES: ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. M&H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC. • WALWORTH COMPANY OF CANADA, LTD.

Reactor core supports of steel, signal bridges of aluminum . . . evidence of B-L-H scope and skill in fabrication

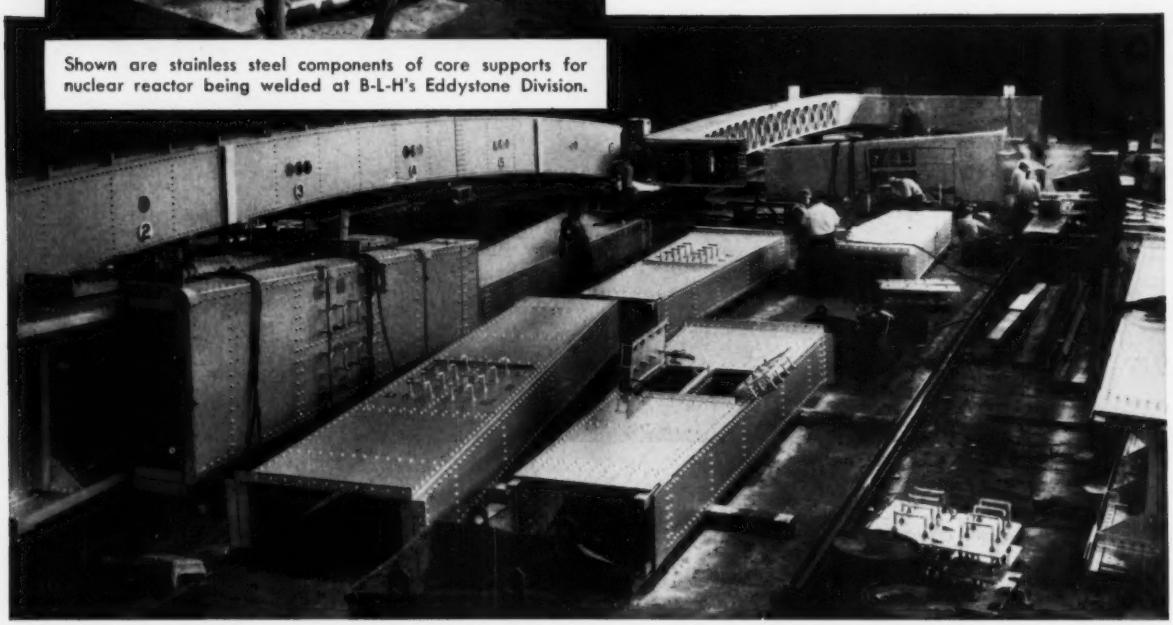
Shown are stainless steel components of core supports for nuclear reactor being welded at B-L-H's Eddystone Division.

Traffic signal bridges or nuclear reactor core supports, 100-ton pressure vessels or a hub and shaft assembly for a wind tunnel—no matter how big or unusual or complex the fabricating job, whether ferrous or nonferrous metals, B-L-H's Eddystone Division can handle it—economically, swiftly, expertly.

The signal bridges (see illustration) were constructed of structural aluminum sections, plates and bars in conformance with the strictest specifications. There are 15 of these structures, and they are 84 feet long. In Eddystone's huge shop—13 bays, each 900 ft. long—handling these giants presented no problem.

The nuclear reactor core supports, fabricated of stainless steel, called for rolling, welding, stress-relieving, and extremely accurate machining. In spite of the close tolerances required, expert planning and accurate manufacturing permitted final assembly of the core and core components with ease and a minimum of selective preassembly.

Write us for a free copy of our illustrated Weldment Bulletin 7001. It will give you an excellent idea of the broad scope of our work.



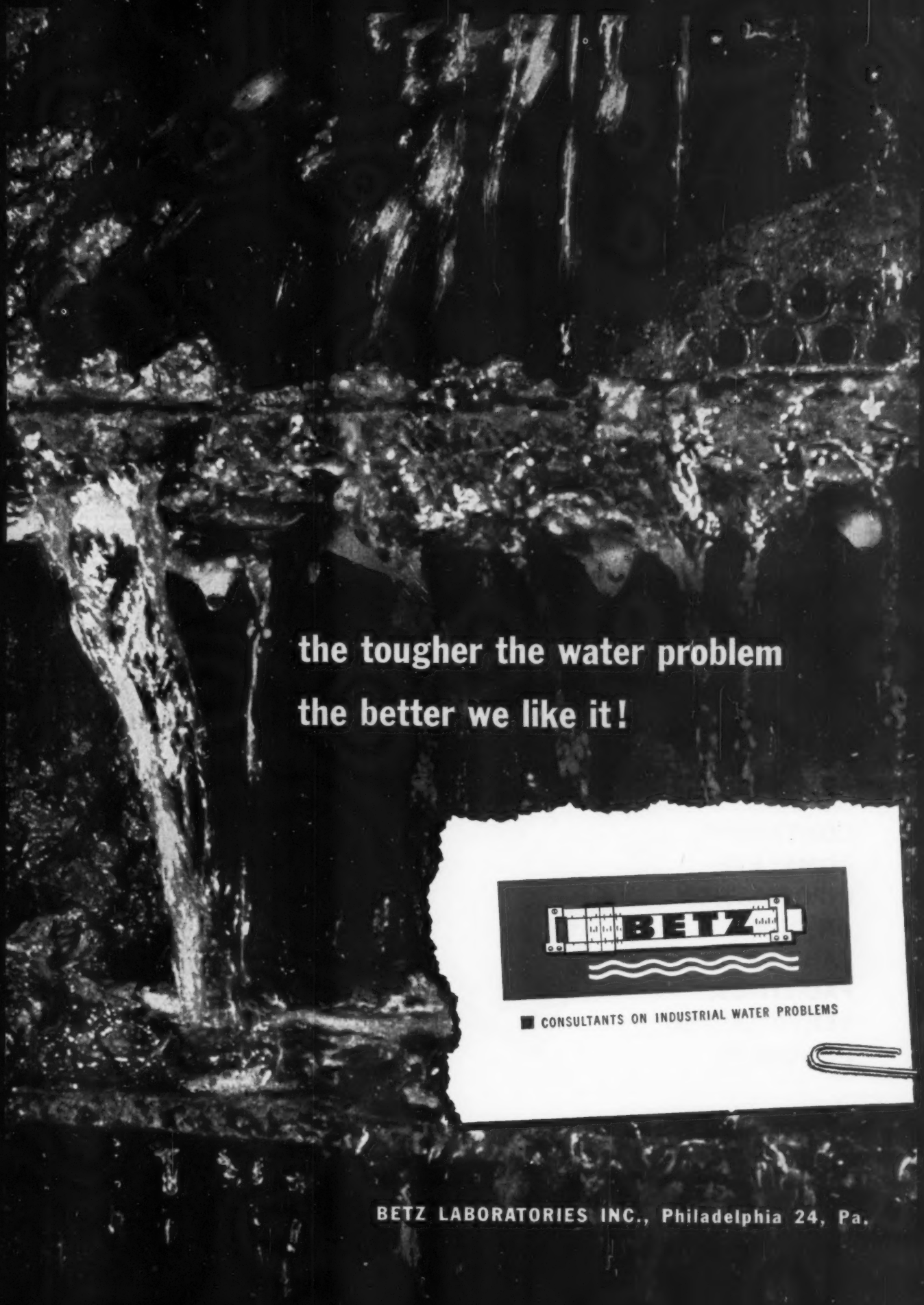
Components of traffic signal bridges for Delaware River Turnpike Bridge in vast fabricating shop at Eddystone.

BALDWIN · LIMA · HAMILTON

Eddystone Division

Philadelphia 42, Pa.

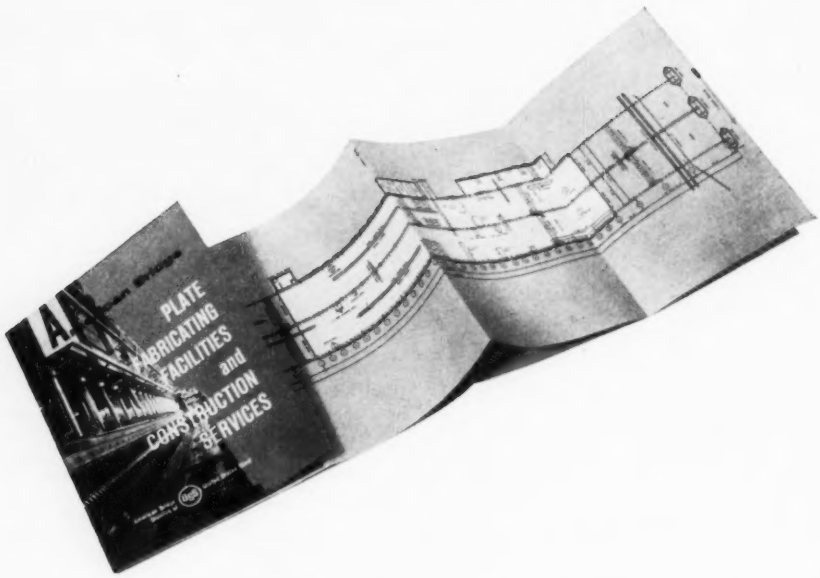
Hydraulic turbines • Weldments • Dump cars • Nonferrous castings • Special machinery • Bending rolls • Machine tools


the tougher the water problem
the better we like it!
BETZ
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS
BETZ LABORATORIES INC., Philadelphia 24, Pa.

ON PAGE 179 OF THIS 1959 ISSUE . . .

YOU WILL FIND THIS CATALOG

CONTAINING COMPLETE INFORMATION ON OUR FABRICATING FACILITIES, SERVICES AND PRODUCTS



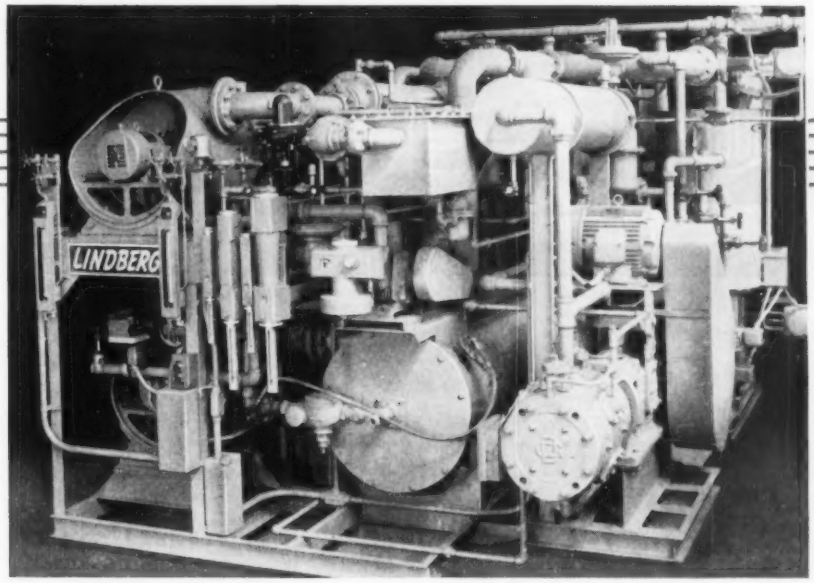
American Bridge Division of USS United States Steel

*Atmosphere of 99.99% inert gases now provided by new Lindberg HYNI Generator

**Completely new, fully automatic, dry process provides highest degree of nitrogen purity

***This process produces nitrogen for only $0.17 to $0.20 per 1000 cubic feet

In chemical processing, this superior nitrogen atmosphere is useful in blanketing processes under non-flammable, non-oxidizing, non-toxic, and bacteria-free conditions. It is ideal, too, for purging, bubble agitation, displacement of air, and pneumatic conveying. In the metals industry, this high purity nitrogen atmosphere is used for annealing, normalizing, brazing, hardening, and sintering. In food processing this inert atmosphere protects product quality, flavor, color, odor and appearance from contamination, oxidation, or bacterial action.



This new HYNI generator is an important addition to Lindberg's complete line of controlled atmosphere generators. It is available in capacities from 1,000 to 10,000 SCFH. Write us for complete information on this remarkable new unit, and other Lindberg generators for any required atmosphere type.

**How The Process Operates

This 99.99% pure atmosphere is produced by a completely new, dry, fully automatic process. It uses the principle of burning a hydrocarbon fuel in a separate catalytic combustion chamber to obtain complete reaction without unburned methane, high residual oxygen or a high percentage of oxides of nitrogen. Carbon dioxide, water vapor, sulphur dioxide or hydrogen sulphide are simultaneously removed in a dry, absorbent material known as Molecular Sieve made by Linde Division of Union Carbide and Chemical Corporation.

*Sample of Analysis Obtainable With HYNI Generator

Oxygen	0.00%
Carbon dioxide	0.01%
Hydrocarbons	0.00%
Water vapor: Less than -80° F. dewpoint (7 p.p.m. when measured by a Beckman Hygrometer)	
Hydrogen	0.00%
Carbon monoxide	0.00%
Sulphur	0.00%
Oxides of nitrogen	0.00%
Nitrogen and Argon (trace)	99.99%

***This Process is Economical

One of the advantages of this process of producing nitrogen is its low cost. With the HYNI Generator the nearly-pure nitrogen is produced for only $0.17 to $0.20 per 1000 cubic feet. Cost of power, raw gas and cooling water is included and based on: fuel gas at $0.60 per 1,000,000 BTU; electricity at $0.01 per KWH; cooling water at $0.05 per 1000 gal. Quoted cost does not include maintenance or amortization. Lindberg quality design and construction assures complete dependability and lowest maintenance cost.

LINDBERG

GAS PROCESSING DIVISION
ENGINEERING COMPANY 2485 West Hubbard Street, Chicago 12, Illinois

To refiners who need more

HYDROGEN
FOR HYDROTREATING

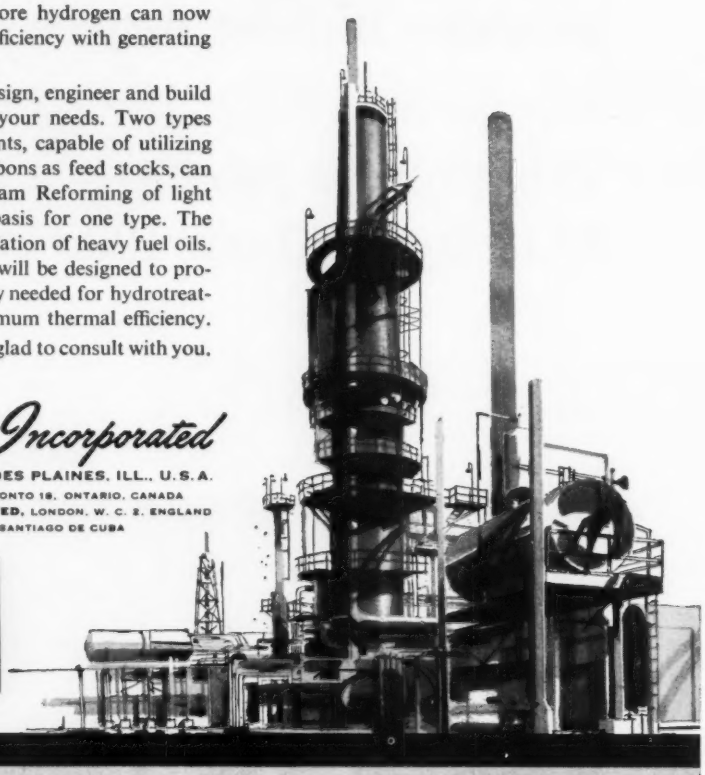
Any refiner who needs more hydrogen can now arrange to make up the deficiency with generating facilities of his own.

Procon is prepared to design, engineer and build a hydrogen plant to suit your needs. Two types of packaged hydrogen plants, capable of utilizing a broad range of hydrocarbons as feed stocks, can be supplied. Catalytic Steam Reforming of light hydrocarbons forms the basis for one type. The other employs Partial Oxidation of heavy fuel oils. With either type, the plant will be designed to produce hydrogen of the purity needed for hydrotreating—and to provide maximum thermal efficiency.

Procon engineers will be glad to consult with you.

PROCON *Incorporated*

1111 MT. PROSPECT ROAD, DES PLAINES, ILL., U.S.A.
PROCON (CANADA) LIMITED, TORONTO 18, ONTARIO, CANADA
PROCON (GREAT BRITAIN) LIMITED, LONDON, W. C. 2, ENGLAND
PROCON INTERNATIONAL S. A., SANTIAGO DE CUBA



plants available from **PROCON***

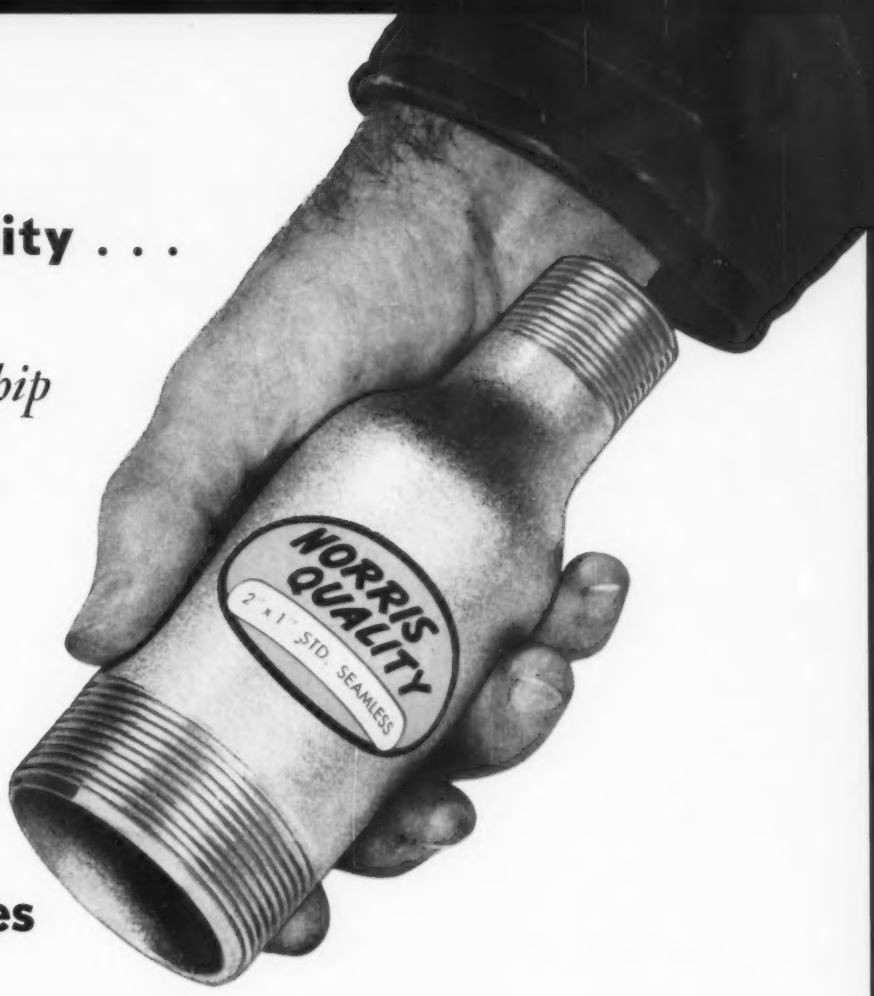
PROCESSES AVAILABLE TO SUIT ANY REFINERY FEED STOCK

*Service includes process design, engineering and construction

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL AND CHEMICAL INDUSTRIES

Feel the Quality . . .

the craftsmanship
the durability



Swaged Nipples by Norris . . .

Your Norris man will be happy to give you complete brochures on all Norris fittings.

There's a size and type for every need . . .

— BAR STOCK —

AISI	C-1025	— All Weights — 1½" and smaller.
AISI	8620	— Schedule 160 — 2" and smaller.
AISI	304	— Stainless Extra Heavy — 2" and smaller.

— PIPE —

ASTM	A-53	— All Weights — 2" and Larger.
ASTM	A-106	— Extra Heavy — All sizes.
ASTM	A-335	— 4 — 6% Chrome, ½% Moly — Extra Heavy — 2" and smaller.

Casing and Tubing sizes are available in grades
H-40 J-55 and N-80

From the world's largest manufacturer of swaged nipples.

NORRIS QUALITY
TUBULAR PRODUCTS

W. C. NORRIS, MANUFACTURER
DIVISION OF DOVER CORPORATION
TULSA, OKLAHOMA

BRANCHES: Great Bend, Kansas; Corpus Christi, Houston, Kilgore, Odessa, Wichita Falls, Texas; Oklahoma City, Oklahoma; Salem, Illinois; Casper, Wyoming; Farmington, New Mexico.

Buy From Your NORRIS Distributor

SEE NORRIS EXHIBIT AT
INTERNATIONAL PETROLEUM EXPOSITION
MAY 14-23, NEAR MAIN ENTRANCE

RING OF STEEL

Defies Pressure Times Ten

The Flexitallic gasket in the bonnet joint of Hancock Steel Gate Valves cannot blow out even if pressures exceed ten times the rating of the valve. Valve maintenance and equipment down-time are greatly reduced. Made of a spiral-wound ribbon of stainless steel with asbestos filler, the gasket has spring-like compressibility — cannot be flattened.

Only the specially-designed Hancock bonnet joint with built-in compression limit can make full use of the positive sealing power of this ring of steel. Such advanced valve engineering is one example of total Hancock quality that assures trouble-free performance. Your nearby industrial supply distributor will gladly explain every economy feature of Hancock Steel Gate Valves. Phone him today.

Hancock 800# Steel Gate Valve, Type 950. Sizes: ¼" thru 2".

MANNING MAXWELL & MOORE, INC. M&M TRADE MARK

HANCOCK STEEL VALVES

A product of

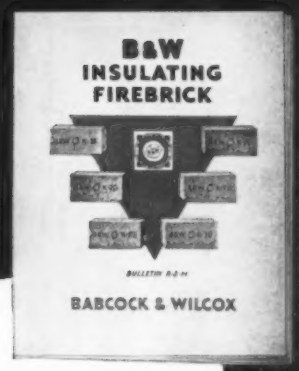
MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

Why B&W IFB for Oil Heater Linings ?

- Lightest weight
- Simplified construction
- High hot load strength
- Lower conductivity
- Lower heat storage
- Better process control



The light weight of B&W Insulating Firebrick provides savings in capital investment in several different ways. The light weight of B&W IFB permits thinner wall constructions of equivalent insulating value. These thinner, lighter walls mean real savings in structural steel and concrete. Construction is further simplified because B&W IFB's high hot load strength makes possible higher unsupported walls without deformation at furnace operating temperatures. In addition B&W IFB can be cut and shaped with ordinary wood working tools, simplifying field installation.

The light weight of B&W Insulating Firebrick also provides the greatest insulation. Thus, they save more fuel.

Light weight also means lower heat storage. B&W IFB protect you against burn-out of expensive alloy tubing in the event of forced shutdown. B&W IFB respond faster to changes in firing rate, too, assuring you of more positive process control.

***Write for Bulletin R-2-H giving more data on B&W Insulating Firebrick.*

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

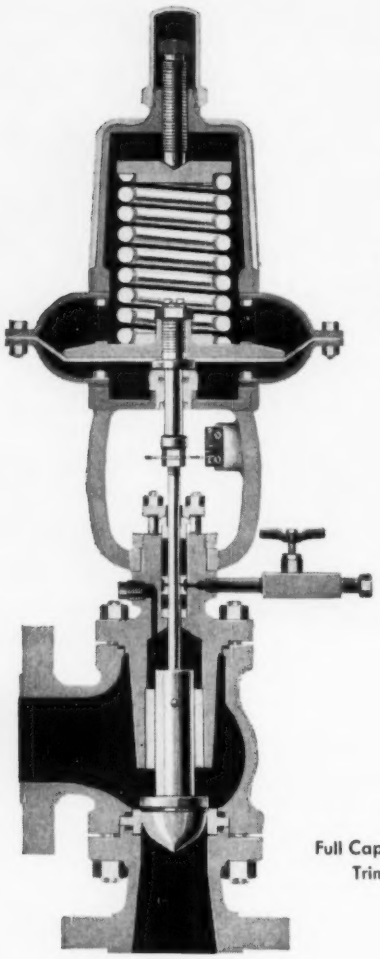
B&W REFRACTORIES PRODUCTS:
B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick
B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide • B&W Ramming Mixes • B&W Kaowool

87

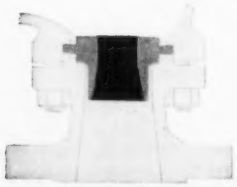
A new and better

ANGLE CONTROL VALVE

. . . for easier maintenance and dependable performance



Full Capacity Trim



40% Capacity Trim

This is a *new* control valve from Honeywell . . . the Type 10 angle valve with body ratings to 600 lbs. Makes piping easier when a valve is needed at a turn. Reduces turbulence and cavitation through an improved venturi effect, when flow is directed to close the valve. And because of the venturi effect, this valve is excellent for slurries, viscous or flashing flow mediums.

CHECK THESE ALL-IN-ONE-VALVE FEATURES:

- **clamped-in seat ring . . .**
  fixed in place . . . gasketed on both sides. Flanged tailpiece permits fast removal, assures good alignment.
- **bolted bonnet . . .**
  allows plug and stem replacement without removing body.
- **flushing connection . . .**
  prevents clogging of guide bushing when slurries are flowing.
- **trim selection . . .**
  full or 40% capacity trim . . . expandable outlets for flashing service.

For further information, contact your local Honeywell field engineer . . . he's as near as your phone. Write for Catalog C800-1. MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.

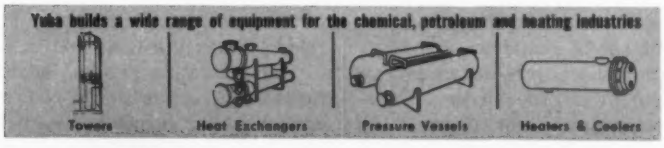
Honeywell

H HONEYWELL *First in Control*

A New and Invaluable Reference Work for Design and Specification of Packless Expansion Joints

Every engineer working with piping that requires precise control of movement of any type, will find this new 76 page booklet one of his most valuable working references. ADSCO Corruflex Packless Expansion Joints in a wide range of metals and alloys, for high and low pressures and temperatures, are fully described and illustrated, with complete engineering and installation data and comprehensive tables of forces, movements and dimensions. You can rely on ADSCO . . . world's largest manufacturer of both packless and slip-type expansion joints.

A complimentary copy will be sent promptly in answer to inquiries. *Complete and attach coupon to your company letterhead, and mail today.*


Yuba builds a wide range of equipment for the chemical, petroleum and heating industries
Towers
Heat Exchangers
Pressure Vessels
Heaters & Coolers

YUBA

ADSCO DIVISION

20 Milburn St., Buffalo 12, N.Y.

YUBA CONSOLIDATED INDUSTRIES, INC.

Plants and Sales Offices

Adsco Division, Yuba Consolidated Industries, Inc.
20 Milburn St., Buffalo 12, N. Y.

Please send me a copy of Bulletin No. 59-50

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Company_____

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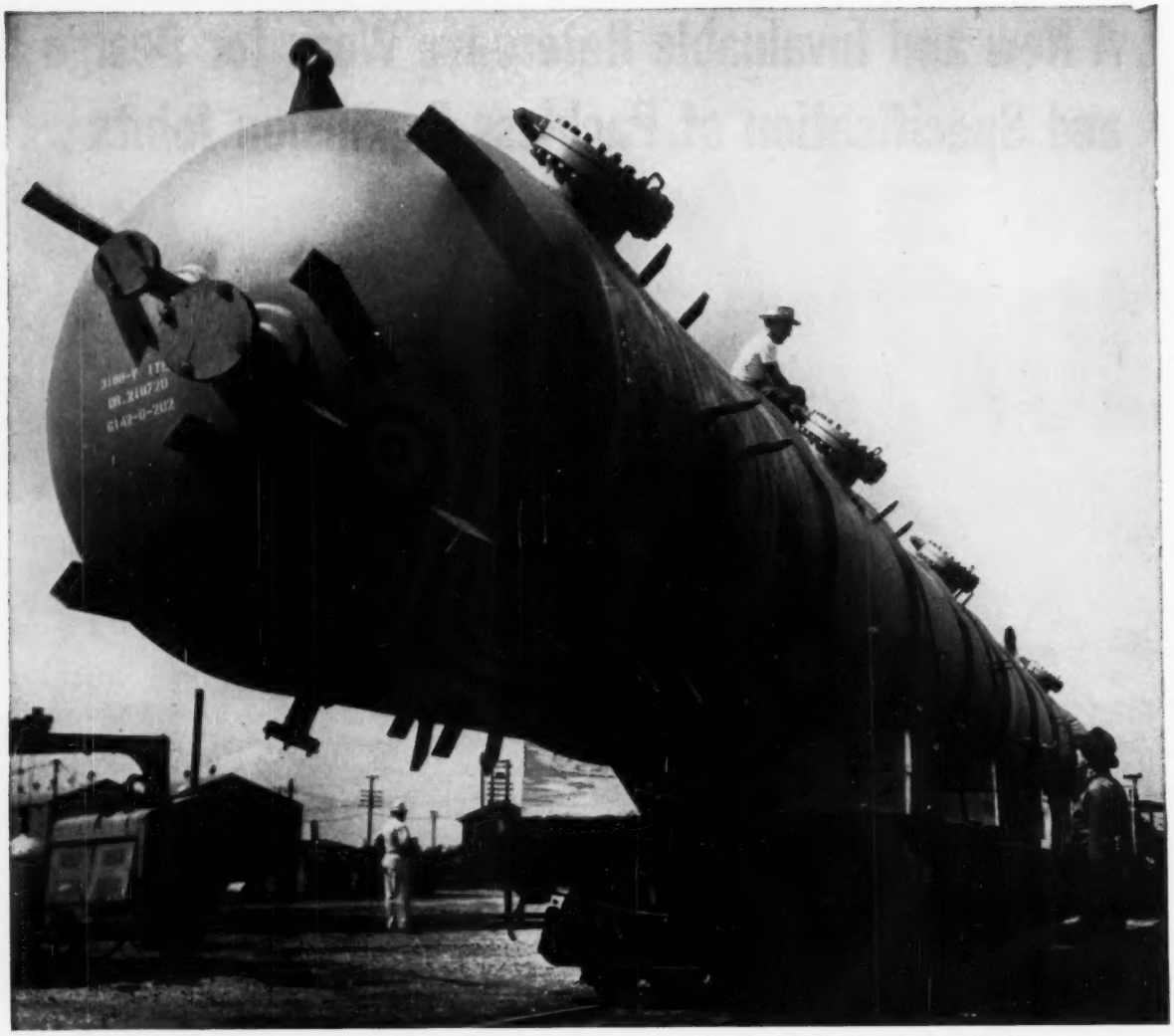
For more data on advertised products, use Readers' Service Cards, last page.



THIS ENTIRE VESSEL was radiographed. Built for use by Socony Mobil Oil Company, Incorporated, it was stress relieved in thirds, and the two joints were stress relieved locally. The unit contains 30 uniflex trays of 96" diameter. Overall weight: 152,000 lbs.

Among the largest in use

...built by Newport News

This Debutanizer with a 110 feet 6 inches over-all length is typical of units that are readily built by Newport News . . .

In fact, Newport News can fabricate almost any type of pressure vessel or other heavy equipment used in the petroleum, chemical or other processing industries.

But at Newport News you'll find more than large productive capacity.

In vast fabricating shops, in huge machine shops, foundries and forging plants, Newport News craftsmen complete your order with specialized techniques. Plant methods . . . developed as a result of specializing for more than half a century . . . enable Newport News to provide money-saving answers to all sorts of heavy equipment problems.

Newport News craftsmen handle the job exactly as you want it done . . . for maximum results per dollar invested. So let us bid on your present or future projects. Learn how Newport News can help you. Send for our illustrated booklet entitled, "Facilities and Products"...it's yours for the asking.

Engineers — Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News Shipbuilding and Dry Dock Company
Newport News, Virginia

Low cost

KOCH FLEXITRAYS

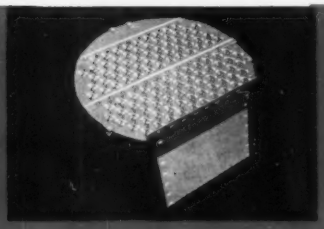
Increase Fractionating Efficiencies in Vickers' new Udex* Extraction Unit

Vickers' new multi-million dollar petrochemical complex built by Procon, Incorporated, is the first petrochemical plant to be built in Kansas, and is expected to produce more than 15 million gallons of petroleum aromatics annually.

Throughout the world, operators have proved that Koch's economical fractionating trays have as much as 25% better efficiency than conventional bell cap trays... give higher capacities, lower pressure drop, and reduce maintenance costs. Over 800 installations have proved the Koch Flexitray's superiority over other devices in capacity, flexibility, and efficiency! KOCH FLEXITRAY—COPIED BY OTHERS—MATCHED BY NONE!

In planning your next tower, consult KOCH!

*Registered Trademark of Universal Oil Products Company



KOCH

ENGINEERING COMPANY, INC.

321 West Douglas Avenue, Wichita 2, Kans.

More than 30 years of tray process design

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Temple Brothers, P. O. Box 7061
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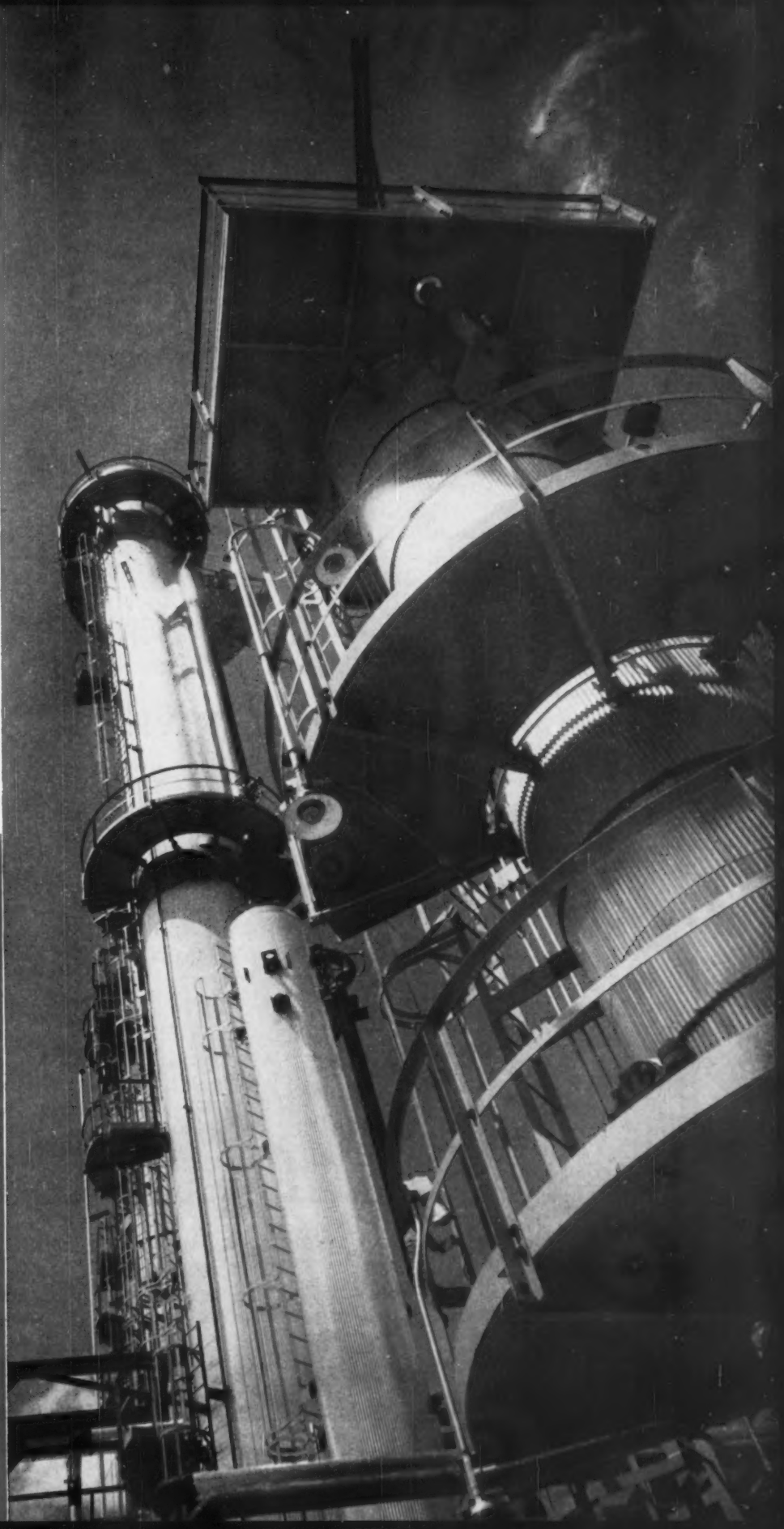
OAKLAND, CALIFORNIA
Engineered Process Equip. Co., 600 Sixteenth St.
PARK RIDGE, ILLINOIS
M. G. Fisher, 1521 Courtland Ave.
PASADENA, CALIFORNIA
Engineered Process Equip. Co., 774 East Green St.
PITTSBURGH 18, PENNSYLVANIA
D. D. Foster Company, 2210 Koppers Bldg.
SALT LAKE CITY, UTAH
C. M. Wallace & Co., Continental Bank Bldg.
SOUTH CHARLESTON, WEST VIRGINIA
D. D. Foster Co., 411 "D" St.
ST. LOUIS 17, MISSOURI
Temple Brothers, 2010 Big Bend Blvd.
TULSA, OKLAHOMA
Myers-Aubrey Co., P. O. Box 5436



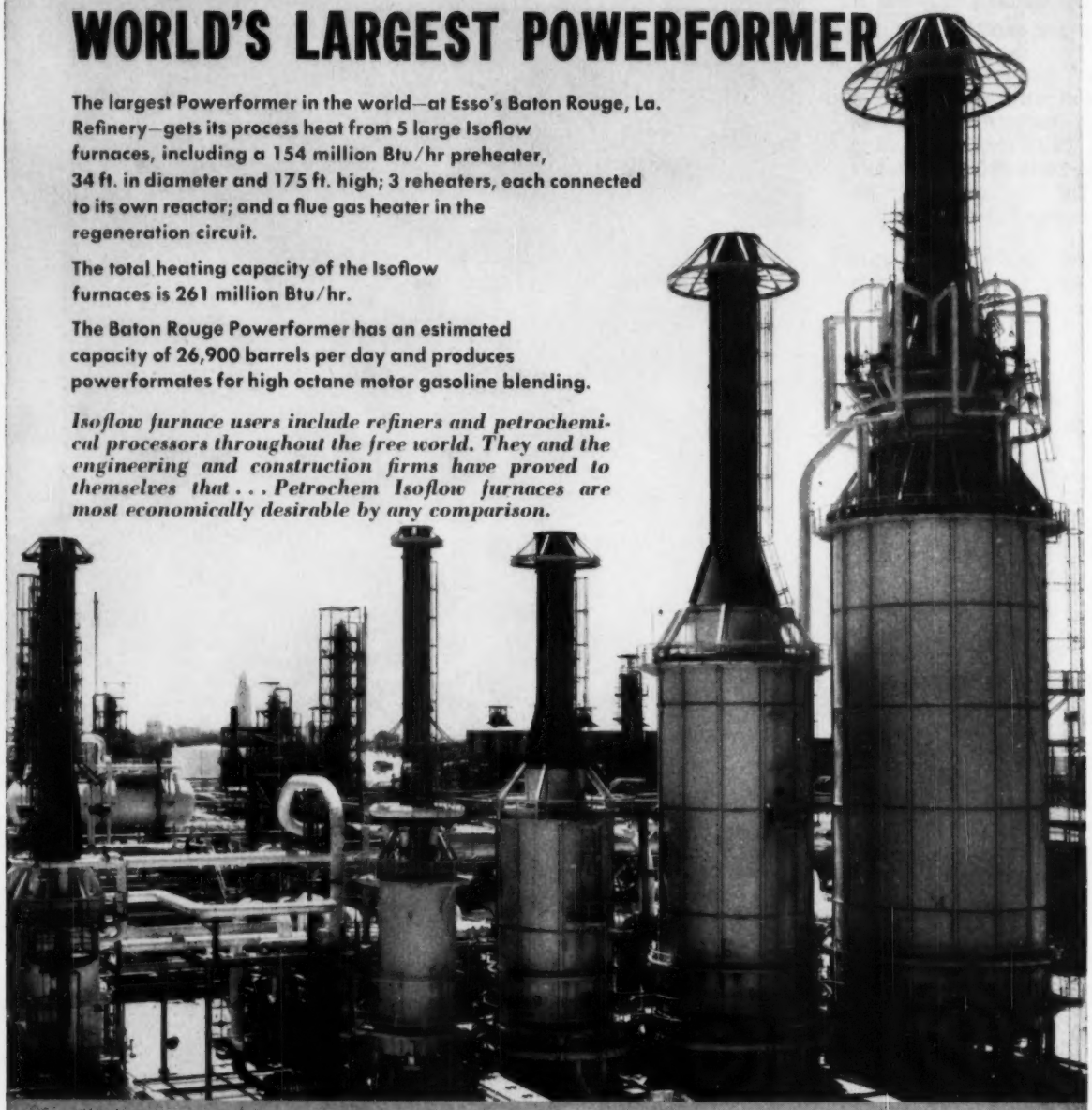
PETROCHEM-ISOFLOW HEATERS
charge
WORLD'S LARGEST POWERFORMER

The largest Powerformer in the world—at Esso's Baton Rouge, La. Refinery—gets its process heat from 5 large Isoflow furnaces, including a 154 million Btu/hr preheater, 34 ft. in diameter and 175 ft. high; 3 reheaters, each connected to its own reactor; and a flue gas heater in the regeneration circuit.

The total heating capacity of the Isoflow furnaces is 261 million Btu/hr.

The Baton Rouge Powerformer has an estimated capacity of 26,900 barrels per day and produces powerformates for high octane motor gasoline blending.

Isoflow furnace users include refiners and petrochemical processors throughout the free world. They and the engineering and construction firms have proved to themselves that . . . Petrochem Isoflow furnaces are most economically desirable by any comparison.



PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

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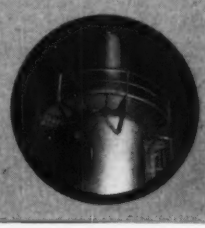
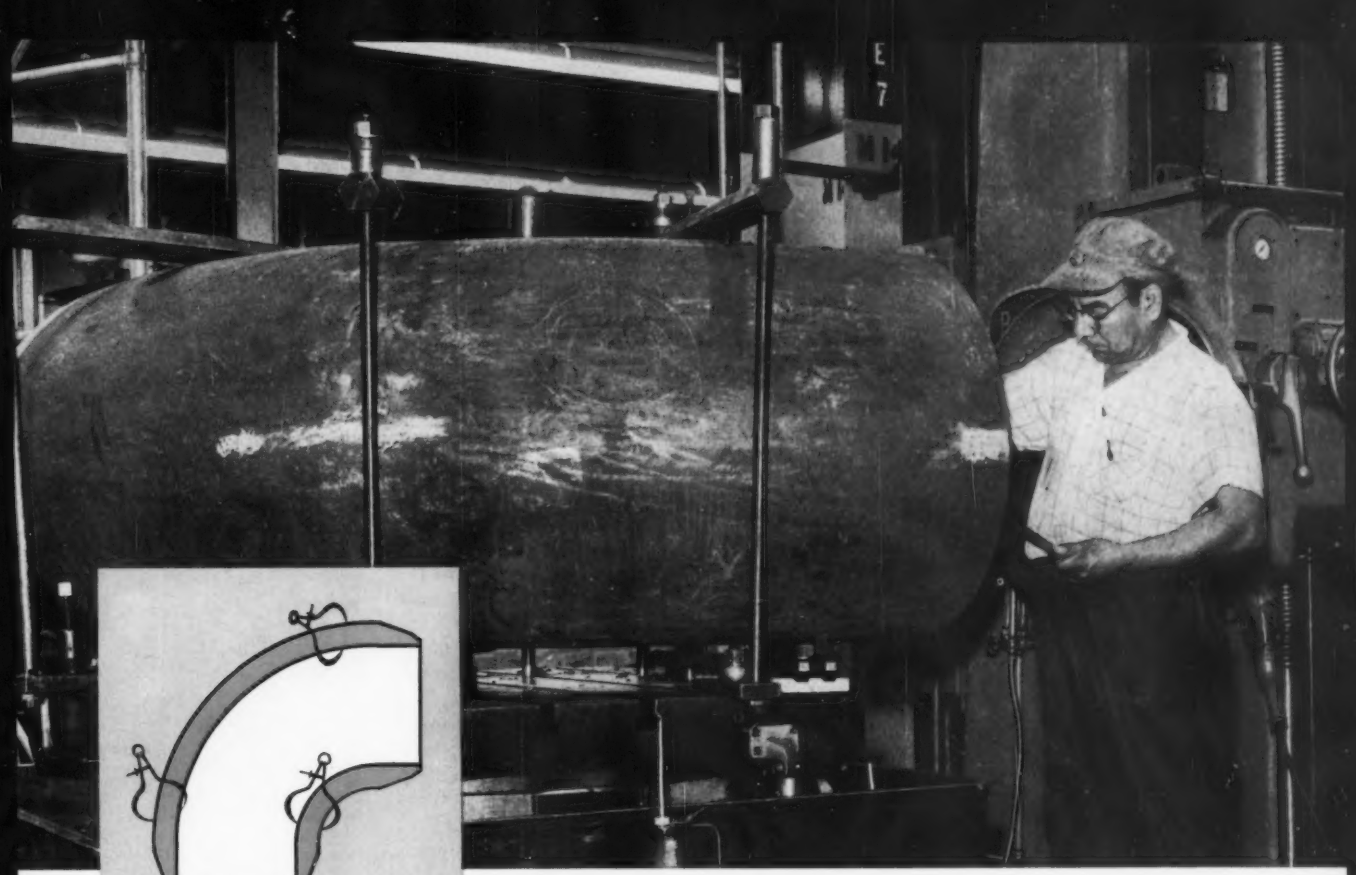
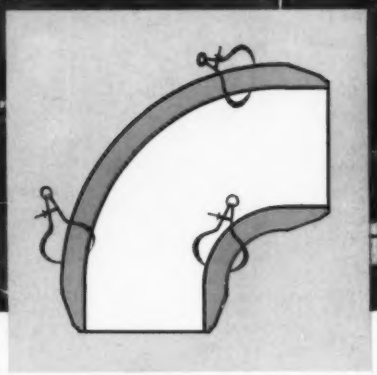






Uniform Wall Elbows

Key-Kast Elbows have cast steel walls of a uniform thickness approximately 15% heavier than the required minimum thickness of pipe walls of the same I.D. For extra highly stressed line sections, the wall thickness and strength can be increased as much as desired — without sacrificing uniformity.

The flexibility of Key-Kast Elbows permit their use in piping systems based on the usual piping stress calculations. Write for engineering bulletin entitled **"Key-Kast Welding Elbows in Piping Stress Calculations."**

Products of W-K-M's *Creative Engineering*

Key-Kast Fittings can handle **any** piping job. Specify them. You'll get outstanding service.

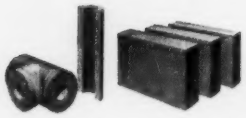
KEY-KAST®—the only cast elbows that meet all requirements for strength and flexibility

KEY-KAST *Uniform Wall* Alloy Steel Welding Elbows will give you outstanding service in any high pressure, high temperature alloy piping application. Only Key-Kast Elbows have cast steel walls of uniform thickness and strength — the most important factor in selecting the right fittings for your job.

Quality controlled through rigid metallurgical standards, Key-Kast Fittings meet ASTM specifications, and ASME and ASA code requirements. Specialists in fluid flow design these fittings to move your lading more safely and efficiently.

Call your Key-Kast representative for prompt, experienced service in selecting the Key-Kast Fitting best for you. Available in all standard shapes, sizes and schedules . . . or specially designed to meet specific conditions of pressure, temperature and lading. *W-K-M Division of ACF Industries, Incorporated, P. O. Box 2117, Houston, Texas.*

W-K-M 40 SERVING INDUSTRY YEARS
DIVISION OF ACF INDUSTRIES INCORPORATED



FOAMGLAS® INSULATION / waterproof, vapor-proof, strong, can't burn, acid-proof, vermin-proof, dimensionally stable

AT ROHM & HAAS CO.—

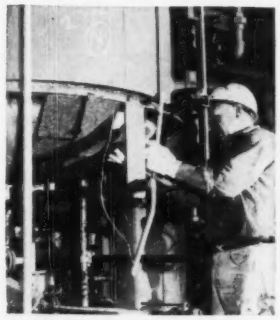
10 year maintenance-free service record backs choice of **FOAMGLAS®** insulation here

Ten years ago, Rohm & Haas Company picked FOAMGLAS to insulate all piping and equipment in a huge new industrial chemicals plant the company built in Deer Park, Texas. Since that time, they've had virtually no insulation maintenance—and the insulation serves as effectively today as when it was installed.

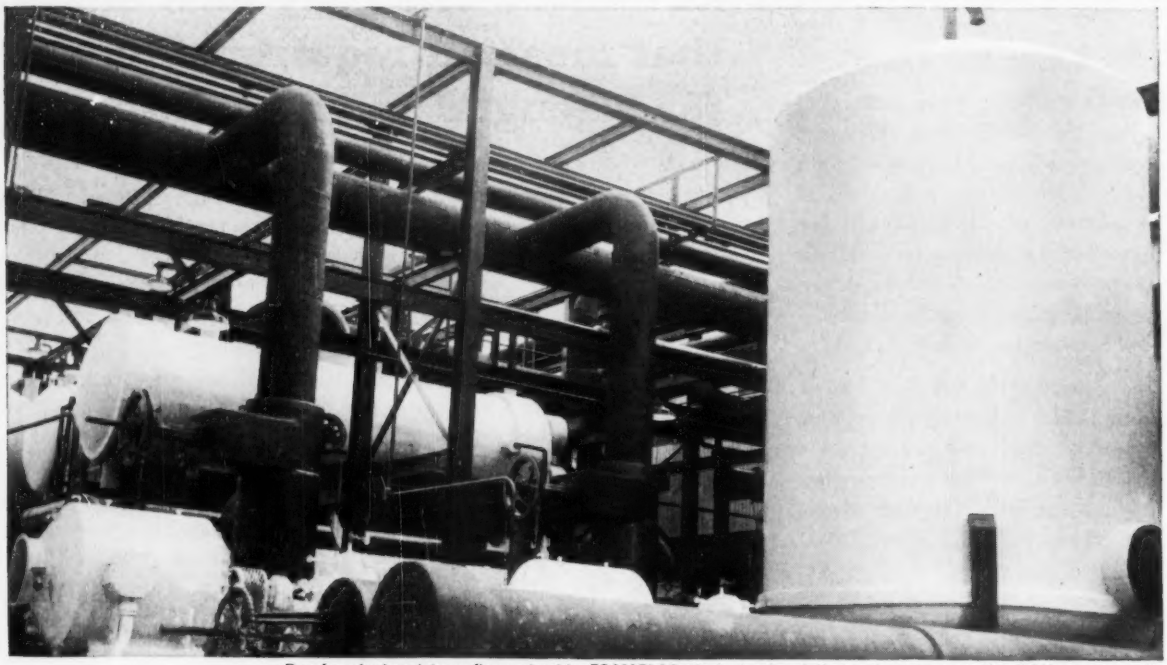
That service record led R & H to pick FOAMGLAS to insulate all piping and equipment for the Deer Park plant's new low temperature processing unit (pictured below).

What makes FOAMGLAS such an effective industrial insulation? This unmatched combination of benefits: FOAMGLAS seals out all moisture to insure insulating efficiency that cannot vary. It is acid-proof. It can't burn. It's quick and easy to install and needs little or no maintenance.

Next time you face the problem of insulating piping or equipment, let Rohm & Haas' experience be your guide. Pick FOAMGLAS. Complete information on this unique cellular glass insulation is contained in our new industrial insulation brochure. To get your free copy, write Pittsburgh Corning Corporation, Dept. Z-49, One Gateway Center, Pittsburgh 22, Pennsylvania. In Canada: 3333 Cavendish Blvd., Montreal, Quebec.



Lightweight, easy to cut and shape, FOAMGLAS saved installation time and money for Rohm & Haas. Installation by the Aber Company.



Proof against moisture, fire and acids, FOAMGLAS eliminates insulation maintenance on this R&H process unit.

PITTSBURGH PC CORNING

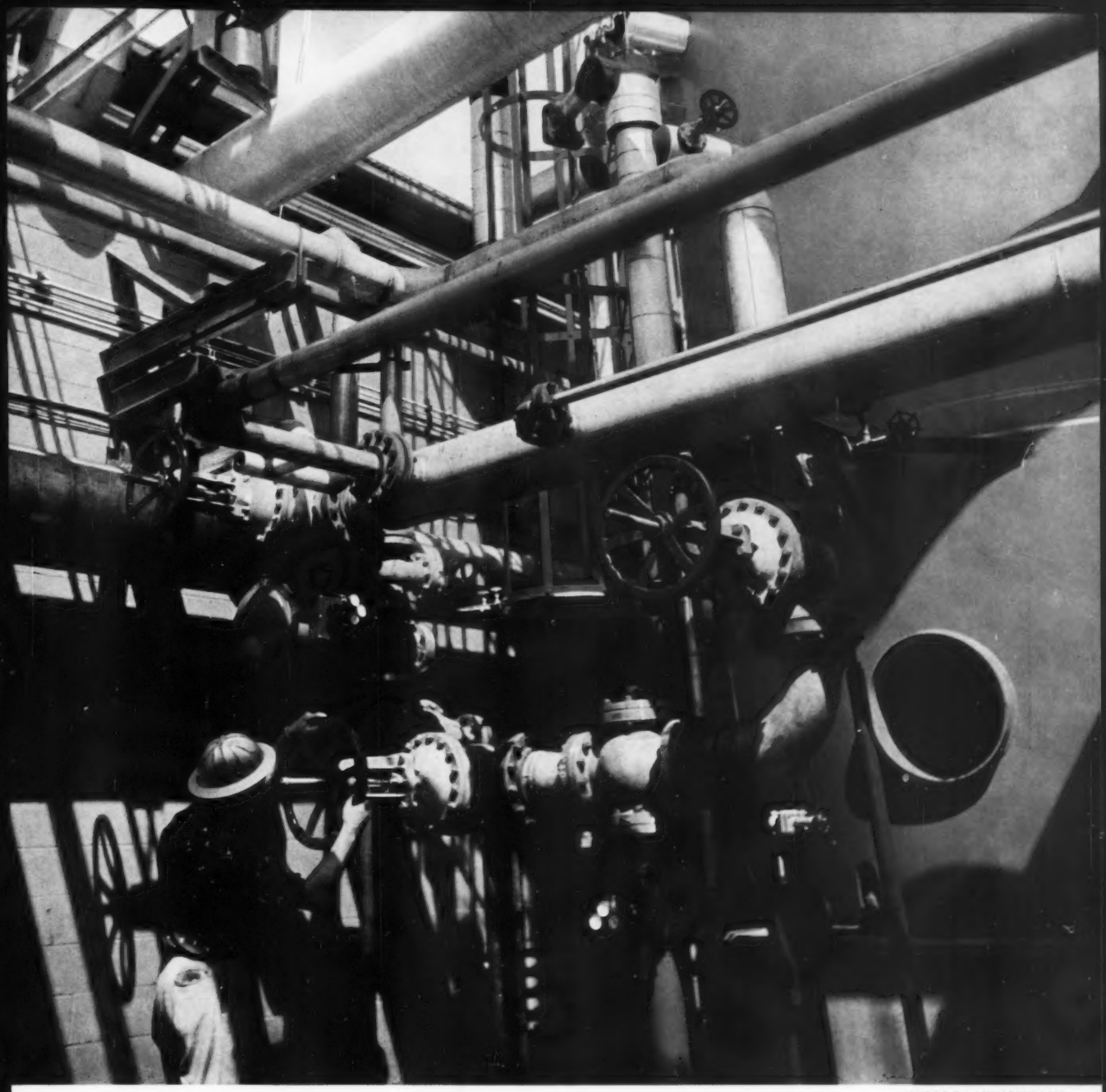


PHOTO ON ANSCOCHROME

SPECIAL PROCESS... General Aniline & Film Corporation's new plant at Linden, N. J., went on stream last year. Built by Scientific Design Co., Inc., it produces ethylene oxide by direct air oxidation of ethylene, Scientific Design's own efficient and economical process. The Aloyco Stainless Steel Valves here (red hand wheels) were selected for their design features and long life expectancy. On your next stainless steel valve job, why don't you talk first to the one company which specializes in high alloy valves exclusively. For further details about Aloyco Valves, write us at 1301 West Elizabeth Avenue, Linden, New Jersey. 95

ALLOY STEEL PRODUCTS COMPANY

Boston · New York · Wilmington · Atlanta · Buffalo · Pittsburgh · Chicago · St. Louis · San Francisco · Los Angeles

In the U.S.A. for the First Time

A Panorama of New Ideas That Can Be Put to Work For You!

All Under One Roof. New York's massive air-conditioned Coliseum is ideally equipped to comfortably accommodate this world-wide event.

To help *you* meet today's needs and prepare for tomorrow's problems, more than 275 major companies from this country and abroad will present the latest materials and equipment, improved and entirely new processes, the most modern techniques, plus nuclear energy applications for use in the petroleum and petrochemical industries.

It's an important opportunity for you to learn the latest developments affecting your industry, to stimulate fresh, new ideas, and benefit from the exchange of information with thousands of the world's leading oil executives, engineers and scientists.

Plan now to attend...and bring your key men with you. Just one idea picked up here will make their visit worthwhile. For advance registration and hotel information write the Exposition at 480 Lexington Avenue, New York 17, N. Y.

5th

WORLD PETROLEUM CONGRESS EXPOSITION

New York Coliseum June 1-5, 1959

Management: International Exposition Co.

1275

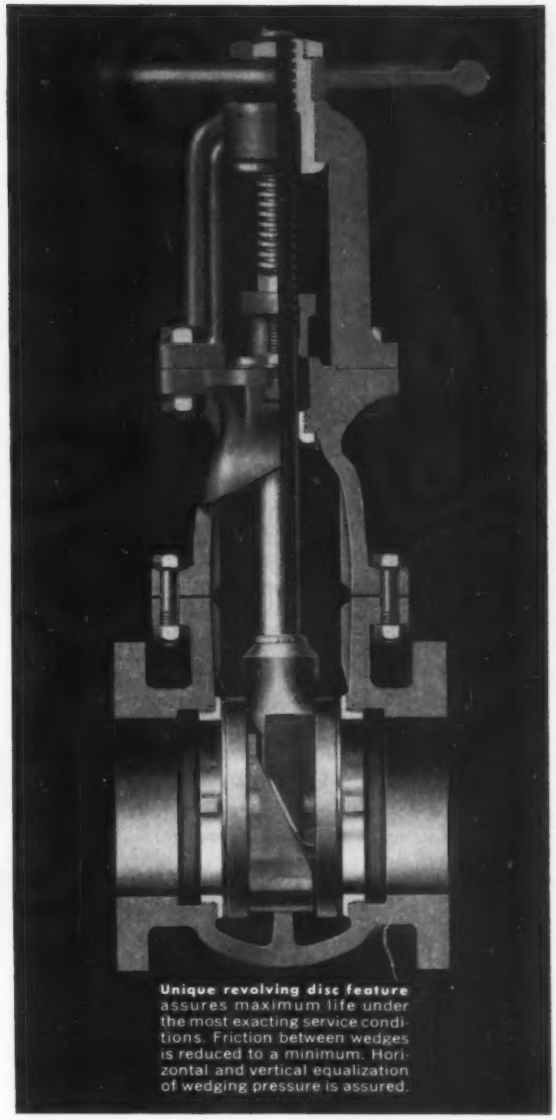
For more data on advertised products, use Readers' Service Cards, last page.

FOR SEVERE CORROSIVE CONDITIONS

Specify

ALUMINUM GATE VALVES

by Darling



Unique revolving disc feature assures maximum life under the most exacting service conditions. Friction between wedges is reduced to a minimum. Horizontal and vertical equalization of wedging pressure is assured.

Handling corrosive chemicals such as hydrogen peroxide, ammonium nitrate, acetic acid, concentrated nitric acid? Darling Aluminum Gate Valves give you longer life, cut maintenance costs, under these and other severe service conditions. Here's why:

Darling metallurgical engineers have thoroughly tested and standardized on the most highly corrosion-resistant aluminum alloys in use today.

Accurate casting control and precision assembly reduces friction and wear, provides maximum ease of operation.

Darling Double Disc Parallel Seat principle assures freedom from leakage, trouble and downtime.

Darling aluminum alloy valves are available in sizes from ½" through 24". Write us about your requirements and service conditions.

DARLING VALVE & MANUFACTURING CO.

Williamsport 31, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

For more data on advertised products, use Readers' Service Cards, last page.

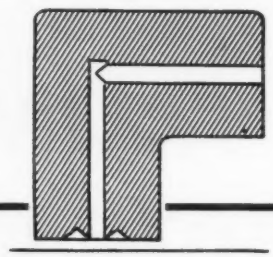
ENGINEERING

NEWS YOU CAN USE ABOUT ENGINE AND COMPRESSOR PERFORMANCE

EXCLUSIVE NEW COOK QUILL* ASSURES BETTER LUBRICATION OF HIGH-PRESSURE PACKINGS

Oil "dripping" has caused a lot of trouble in high-pressure packings. The surface tension of the heavier oils tended to foul the nozzle, bleeding the lubricant down inside the cup bore instead of on the rod. Result: intermittent feeding or none at all. A new Cook-engineered drip nozzle design has solved this problem. Key to the new design is a Teflon quill that extends beyond the cup inner bore and actually *touches* the rod. Even after long wear, the quill will be within a few thousandths-of-an-inch of touching the rod. Thus, oil gradually bleeds onto rod . . . doesn't drop. This means that it will maintain a satisfactory oil film on the rod at all times. The exclusive quill is now standard on all Cook steel packings from 4,000 PSI upward. Ask a C. Lee Cook representative to give you the details.

**Patent Pending*



"IMPROVE YOUR PISTON RING PERFORMANCE"

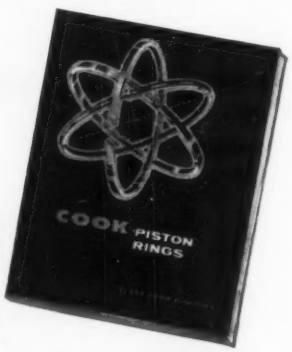
SEND FOR FREE 8-PAGE BOOKLET

Write for your free copy of this technical article. Gives valuable data on improving your engine's performance and keeping it high for longer periods by better cylinder sealing. Offers practical advice on (1) how to tell whether rings should be reused or replaced, (2) choosing a ring setup, (3) relieving top ring load, and other problems. In short, it's a brief, handy guide to better piston ring performance. For your copy, write C. Lee Cook Company, 950 So. 8th St., Louisville 3, Ky.

SEE OUR EXHIBIT

BOOTHS 51 and 52 TEXAS BLDG.

WRITE FOR COOK'S NEW PISTON RING CATALOG



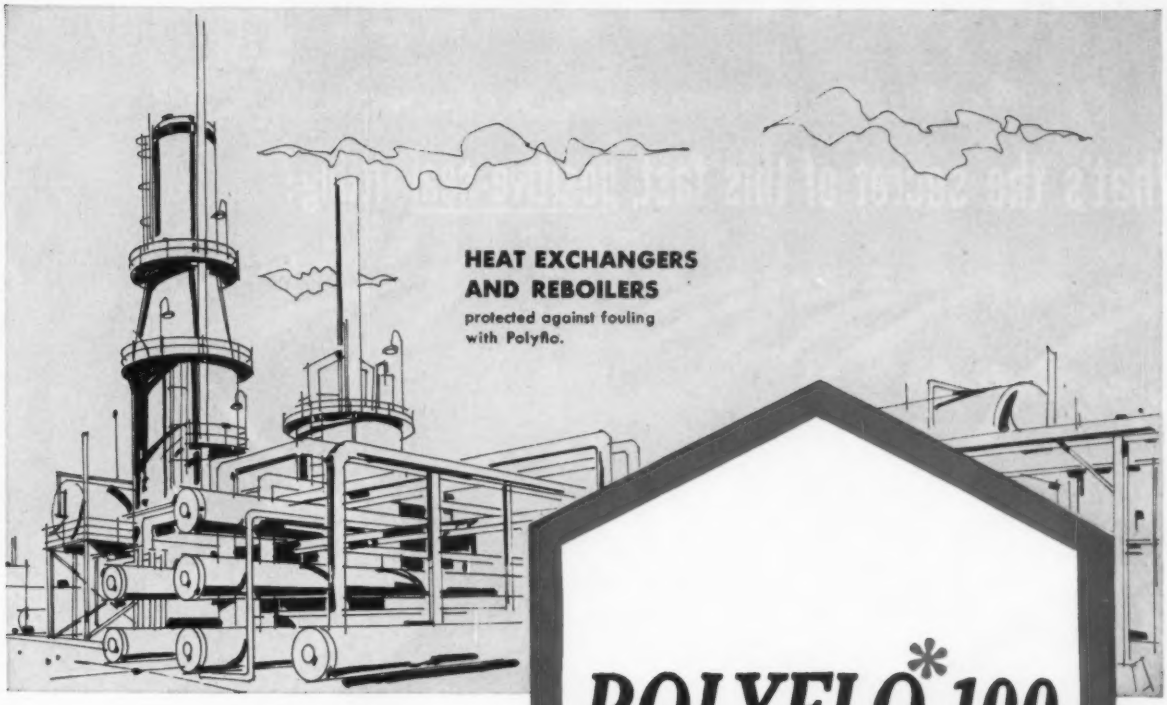
Sixteen-page catalog just off the press. Describes complete line of piston rings manufactured by C. Lee Cook Company, also the special rings of the Airtomics Division. For your free copy, write: C. Lee Cook Company, 950 South 8th Street, Louisville 3, Kentucky.

C. LEE COOK COMPANY

Division of Dover Corporation

Rings and Packings Since 1888

For more data on advertised products, use Readers' Service Cards, last page.



HEAT EXCHANGERS AND REBOILERS
protected against fouling with Polyflo.

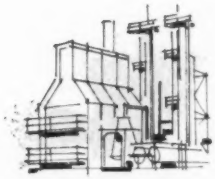
NOW... POLYFLO* 100

1 Multi-purpose Inhibitor-dispersant solves 5 pressing problems

A highly convenient all-around inhibitor-dispersant, UOP Polyflo 100 is also an effective stabilizer against thermal changes, color deterioration, sludge and deposit formation.

An effective dispersant for distillate, residual and crude oils, Polyflo 100 also eliminates fouling and sludge formation in heat exchangers and storage tanks.

Polyflo is but one of a variety of inhibitors and additives developed by UOP for petroleum refiners. Write our Products Department for detailed information on these products. Ask also about the services of our staff of treating field engineers, who will gladly work with you to solve specific problems.



No. 2 HEATING OIL
stabilized against color deterioration and sludge deposition.

DIESEL FUELS
also effectively stabilized with Polyflo.

OIL STORAGE TANKS
for distillate, residual and crude oils—kept free of tank bottoms.

JET FUELS
attain thermal stability with Polyflo.

* TRADEMARK

UOP®

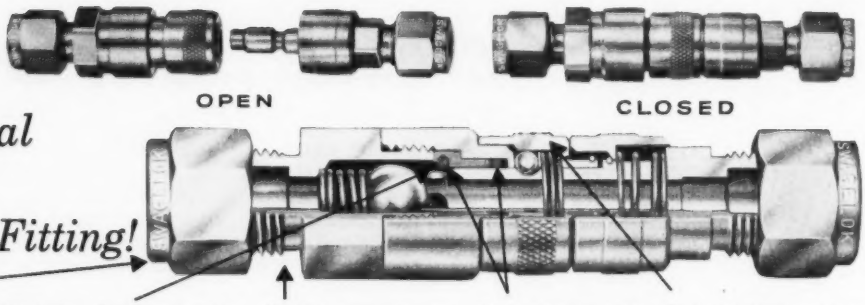
UNIVERSAL OIL PRODUCTS COMPANY
30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U.S.A.

For more data on advertised products, use Readers' Service Cards, last page.

What's the secret of this fast, positive-seal fitting?

Swagelok Quick-Connect Fitting Installation in Boeing Airplane Company, Seattle, Wash., Test Facilities for Boeing 707 Jet Stratoliner.

Here's the secret of this fast, positive-seal Swagelok Quick-Connect Fitting!



1. Swagelok Quick-Connects with single end or double end shut off for tube to pipe, tube to tube, bulkhead tube to tube applications are available in brass and stainless steel in sizes for ¼" and ⅜" O. D. tubing.

2. Flow resumed instantly and vacuum tight seal assured when connection is made.

3. Light, compact, streamlined design. Occupies little space. For use with portable equipment, and bulkhead or panel applications.

4. Instant-acting seals completely prevent loss of pressure when fitting is disconnected.

5. No twisting, turning or wrench action necessary. Easy straight-line finger tip pull or push action for instant connecting or disconnecting.

In the Boeing Airplane Company photo shown above, the tubes are instrumentation pressure lines running from the large jet engines on test stands to the patch board, where the lines are coupled into measuring devices.

The Boeing Airplane Company adopted this positive Swagelok Quick-Connect Fitting to simplify test installations, and substantially cut down test set-up time. Both ends of the many pressure lines are Swagelok-equipped. Previously, engineers used a screw-type fitting which required a wrench and valuable time-consuming operations to tighten and remove.

Swagelok engineers are equipped with experience, ability, and a wide range of tube fittings designed to meet your individual problems. Quick delivery of Swagelok tube fittings from local distributor stocks.

Swagelok® TUBE FITTINGS

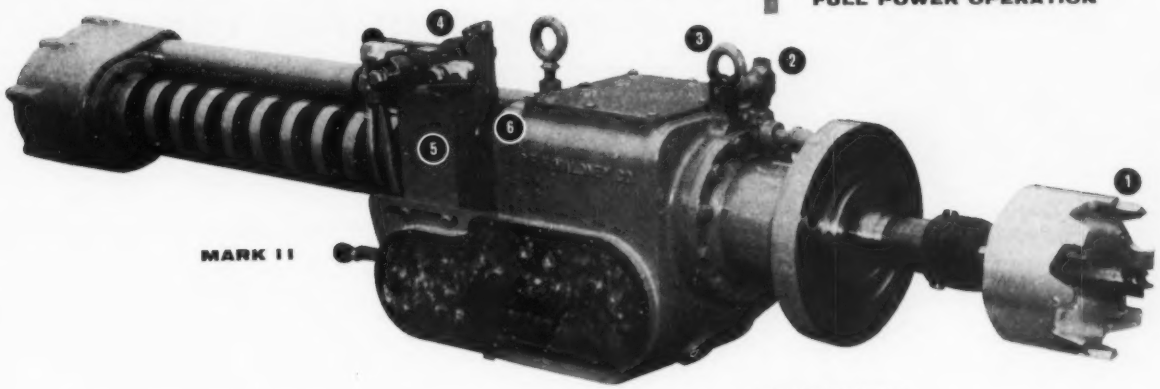
CRAWFORD FITTING COMPANY
884 East 140th Street, Cleveland 10, Ohio
Crawford Fittings (Canada) Ltd., Niagara Falls, Canada

Completely NEW High-Pressure Pipe Tapping Machines

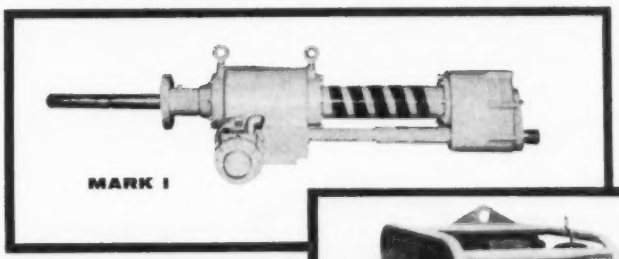
Maloney

MARK I
1 to 6 inch
air or hand crank

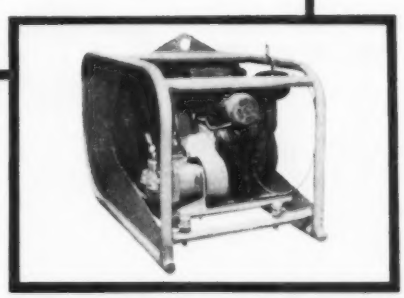
MARK II
4 to 16 inch
air or hydraulic
FULL POWER OPERATION



Over two years of intensive research and field testing have produced these all new high-pressure Tapping Machines. Conservatively rated at 1440 psi at 100° or 700 psi at 700°, the Maloney MARK I and MARK II incorporate every desired feature for rapid, safe, and accurate hot tapping, with complete power operation. Engineered and manufactured by the F. H. Maloney Company, completely within our own manufacturing facilities.



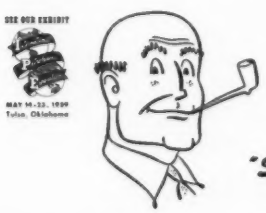
Based on the same design as the MARK II, the MARK I covers the range of high pressure taps from 1 inch to 6 inch. Available with air motor or hand crank operation, the MARK I is rated at the same operating pressures and temperatures as the MARK II. Twist drill cutters are available to 3 inch, shell type cutters to 6 inch. (MARK I Air Requirements 90 psi, @ 105 cfm.)



Companion Hydraulic Power Unit powered with 9 hp gasoline engine, completely self-contained. Provides ample power and positive control of cutter torque with calibrated, infinitely variable, flow control. Available as an accessory with the MARK II. (MARK II Air Requirements — 90 psi, @ 105 cfm.)

FEATURING

1. Revolutionary shell cutters provide cleaner cutting with less torque. Replaceable teeth, shell, and backplate for field maintenance.
2. Integral bleed-off valve.
3. Center of gravity well forward, near the cutting end of the machine, for easier handling. Vertical and horizontal operation with built-in lifting rings and bail.
4. Air or Hydraulic power (MARK II only), with ample reserve power. Completely reversible—makes the *full range* of cuts without alteration.
5. All operating controls grouped for simple operation.
6. Boring bar travel counter measures travel in .01 inch increments. No guessing where the cutter is.
7. Simplified design eliminates unnecessary maintenance. Designed to be operated and maintained by *your* operating personnel.



New
"Something From the Irishman"

F. H. Maloney COMPANY

Post Office Box 1777 • Houston 1, Texas

CHICAGO • LOS ANGELES • PITTSBURGH • TULSA

For more data on advertised products, use Readers' Service Cards, last page.

MUELLER®

B-100 drilling, tapping and inserting machine

...makes connections to steel or cast iron pipe lines under pressure!

No interruption of flow!
No draining of lines!
No loss of fluid!
No welding!

Just 3 simple steps are needed to make a safe, permanent connection with the new Mueller B-100 Machine.
1. Drill and tap a hole in the pipe line.
2. Insert a tee (in closed position) or stop into the tapped hole and remove machine.
3. Attach piping and "open" tee or stop.

Connection is made quickly, safely and simply - under pressure!

The B-100 Machine is designed for either hand operation or for use with Mueller's new H-603 Electric Power Operator or H-604 Air Power Operator. Both power operators provide automatic feed during the drilling operation and are reversible to permit power withdrawal of the tool.

B-100 Machine
Pressures to 250 p.s.i.

insert these

MUELLER NO-BLO® Products

Machine-Inserted Valve Tees
Pressures to 250 p.s.i.
Sizes: ½" x ¾", ¾", ¾" x 1"

Machine-Inserted Bronze Stop
Size: ¾"

H-11071 Bronze Stop
Sizes: ½", ¾", 1"

H-11070 Bronze Stop
Sizes: ½", ¾", 1"

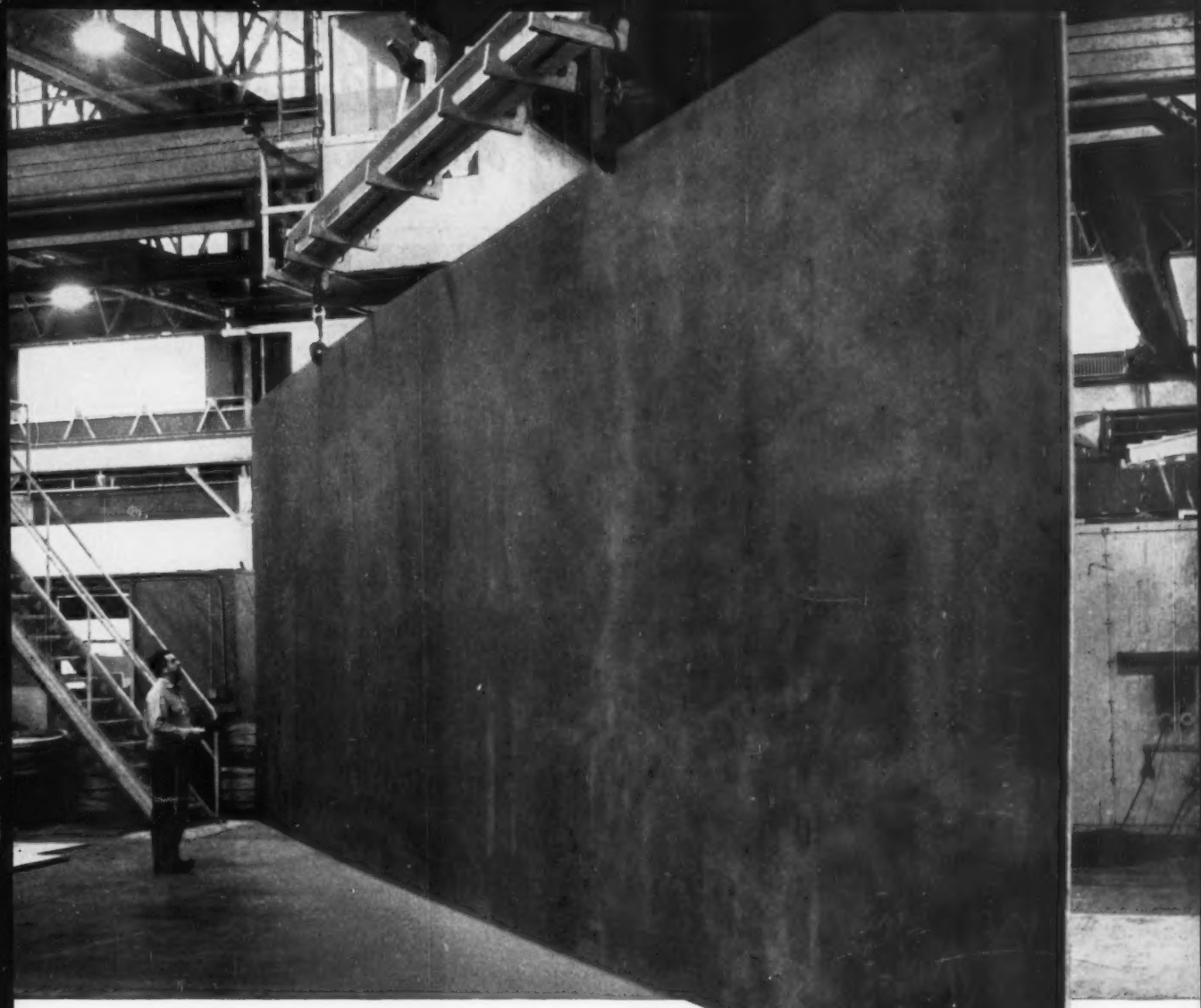
These fittings have a special compression joint inlet and are ideal for use with thin wall or small diameter pipe.

Write today for complete details and specifications.

MUELLER CO. Since 1857 SERVING the Water and Gas Industries QUALITY

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles;
In Canada: Mueller, Limited, Sarnia, Ontario



sure it's big

. . . but not particularly big or unusual in Carlson's production of stainless steel plate

IT was normal, but not easy, for Carlson specialists to handle this big plate. Type 304-L stainless, it measured $\frac{7}{16}$" x 131$\frac{1}{2}$" x 452$\frac{9}{16}$" and weighed an impressive 7923 pounds. And when this big one landed at the customer's receiving dock it was *exactly* what he wanted . . . *right* by chemical composition, *right* by physical standards, *right* to specification and *right* to size.

Whatever you need in stainless steel—big plates, small rings, formed or cut-to-shape items—will be produced accurately and on time. Stainless steel is our *only* business, and we know it. That is why you can depend on Carlson to give you *what you want when you want it!* Your inquiry is invited.

G.O.CARLSON *Inc.*

Stainless Steels Exclusively

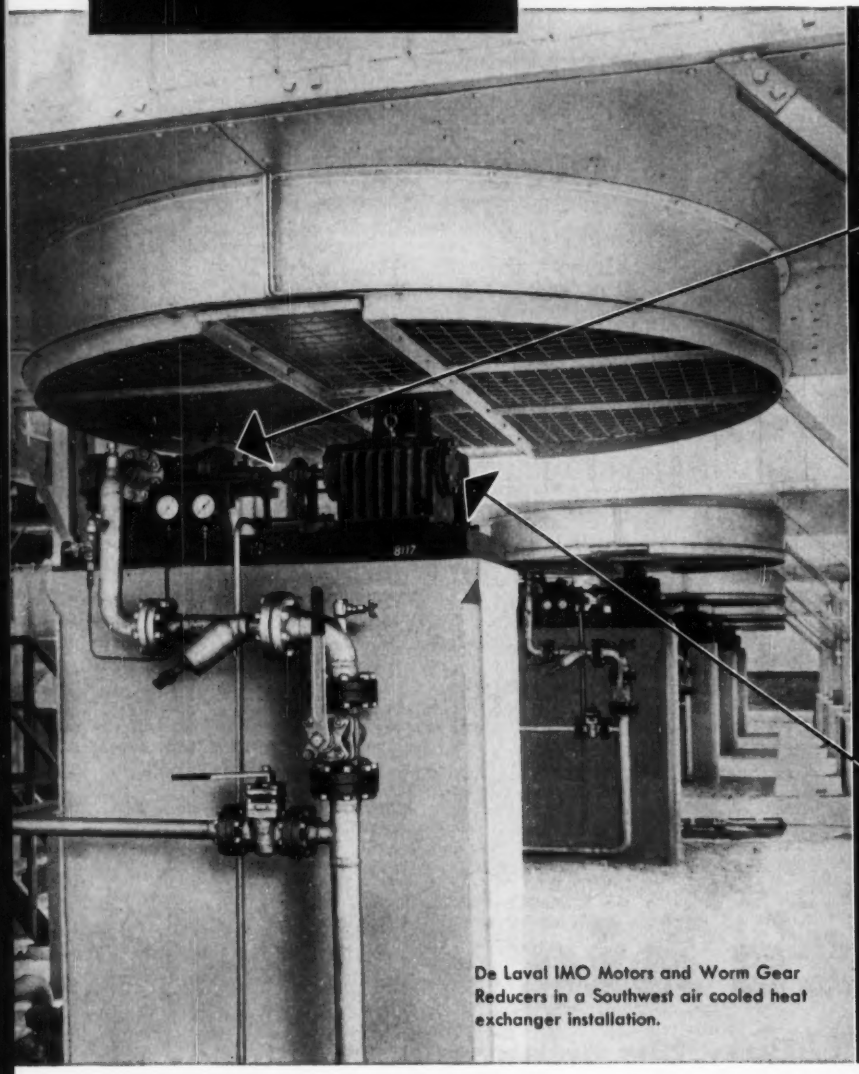
136 Marshalton Road
THORNDALE, PENNSYLVANIA
District Sales Offices in Principal Cities

C

PLATES • PLATE PRODUCTS • HEADS • RINGS • CIRCLES • FLANGES • FORGINGS • BARS AND SHEETS (No. 1 Finish)

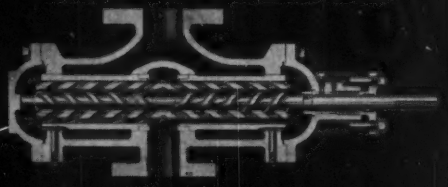
DE LAVAL
HYDRAULIC FAN DRIVES

do dependable, power-saving job in air-cooled cooling towers



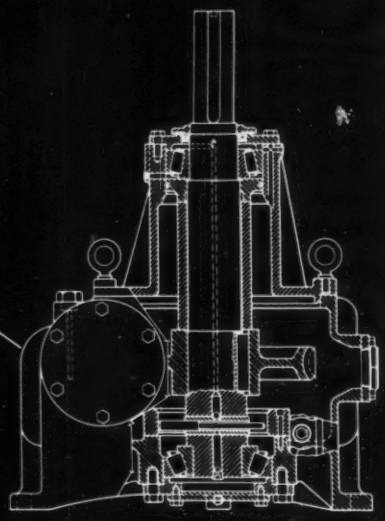
De Laval IMO Motors and Worm Gear Reducers in a Southwest air cooled heat exchanger installation.

De Laval IMO Motors and Pumps



simple, reliable, pulsation-free

De Laval Worm Gear Speed Reducers



ruggedly built for severe service

De Laval Hydraulic Fan Drives for air cooled heat exchangers and cooling towers *save power* since the fan operates at full speed only a portion of the time. Furthermore, there is no demand charge on hydraulic power. • Equally important, they provide *accurate*, *automatic* control of engine jacket water temperature, and also assure *complete operational flexibility*. Due to the simplicity of De Laval IMO motors and pumps as well as the rugged construction of De Laval Worm Gear Reducers, these units stay on the job for years. Both IMO motor and speed reducer are mounted and factory aligned on a single bedplate.

Investigate *all* the advantages of De Laval Hydraulic Fan Drives. Send for your copy of Bulletin 3009 which includes helpful performance data.

DE LAVAL *Hydraulic Fan Drives*

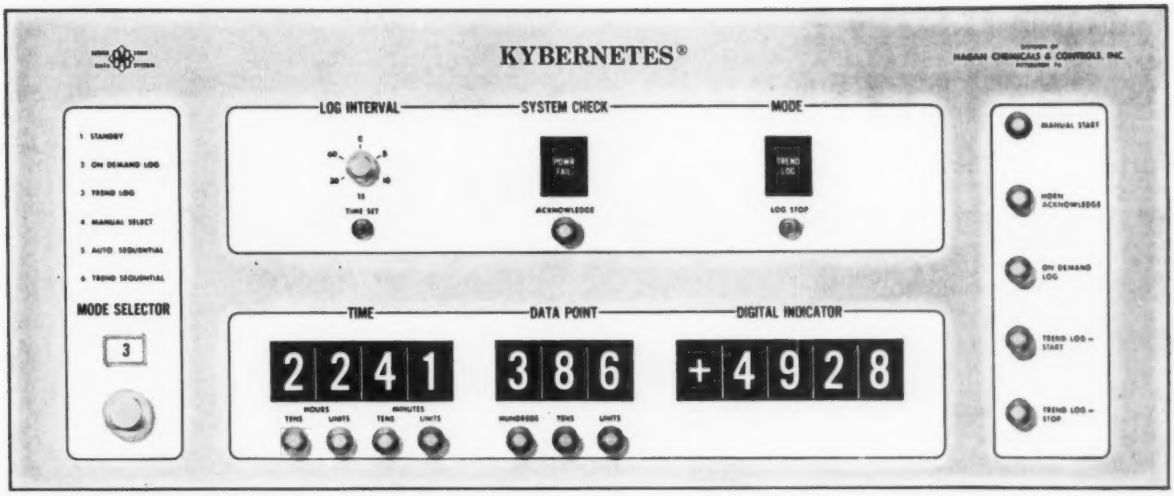
DE LAVAL STEAM TURBINE COMPANY

811 Nottingham Way, Trenton 2, New Jersey

DL370

Hagan Chemicals & Controls, Inc., announces the

COMPLETELY NEW



Kybernetes Series 2000 Data Processing System

The new Kybernetes Series 2000 Data Processing System, utilizing solid state components, adds many data handling advances to the outstanding features of the original equipment. Here are some of the features the new Kybernetes system has to offer:

NEW FLEXIBILITY—Basic unit is a simple logging unit for recording process data on a log sheet or other output device. This basic system can be expanded easily, both in terms of the number of points scanned, and the complexity of the operations performed by the unit. For example these can be added as need develops: *Scanning for off-normal conditions—Printed or visual trend of selected variables—Computing and integrating—Automatic programming and optimum setting of control.*

NOTE—*Any* or *all* of these functions may be performed without interrupting any of the other functions. Off-normal scanning *always* proceeds uninterrupted.

OPTIMUM RELIABILITY—Fewer components, simplified design logic and solid state components add to the inherent reliability of the system. All parts have been selected for long life and easy maintenance.

MODULAR CONSTRUCTION simplifies extension of system. Each new function can be added by simply plugging-in appropriate module.

SELF-CHECKING CIRCUITS immediately signal malfunction in any area and spot the area with a warning light.

ACCURACY of 0.1% on all inputs, including non-linear types is achieved by eliminating marginal techniques and components, using the highest quality components and by the use of simplified design logic.

Flexible, accurate and reliable, the new Kybernetes Series 2000 Data Processing System offers many previously unattainable advantages. Designed for maximum usefulness with minimum investment, *the new Kybernetes system permits the addition of functions as needed, including complete computer control.* A new brochure describes these advantages in detail. Write today for your copy; ask for Bulletin MSP-161.

HAGAN CHEMICALS & CONTROLS, INC.

DIVISIONS: CALGON COMPANY, HALL LABORATORIES

HAGAN BUILDING, PITTSBURGH 30, PA.
In Canada: Hagan Corporation (Canada) Limited, Toronto
European Division: Via Flumendosa No. 13, Milano, Italy

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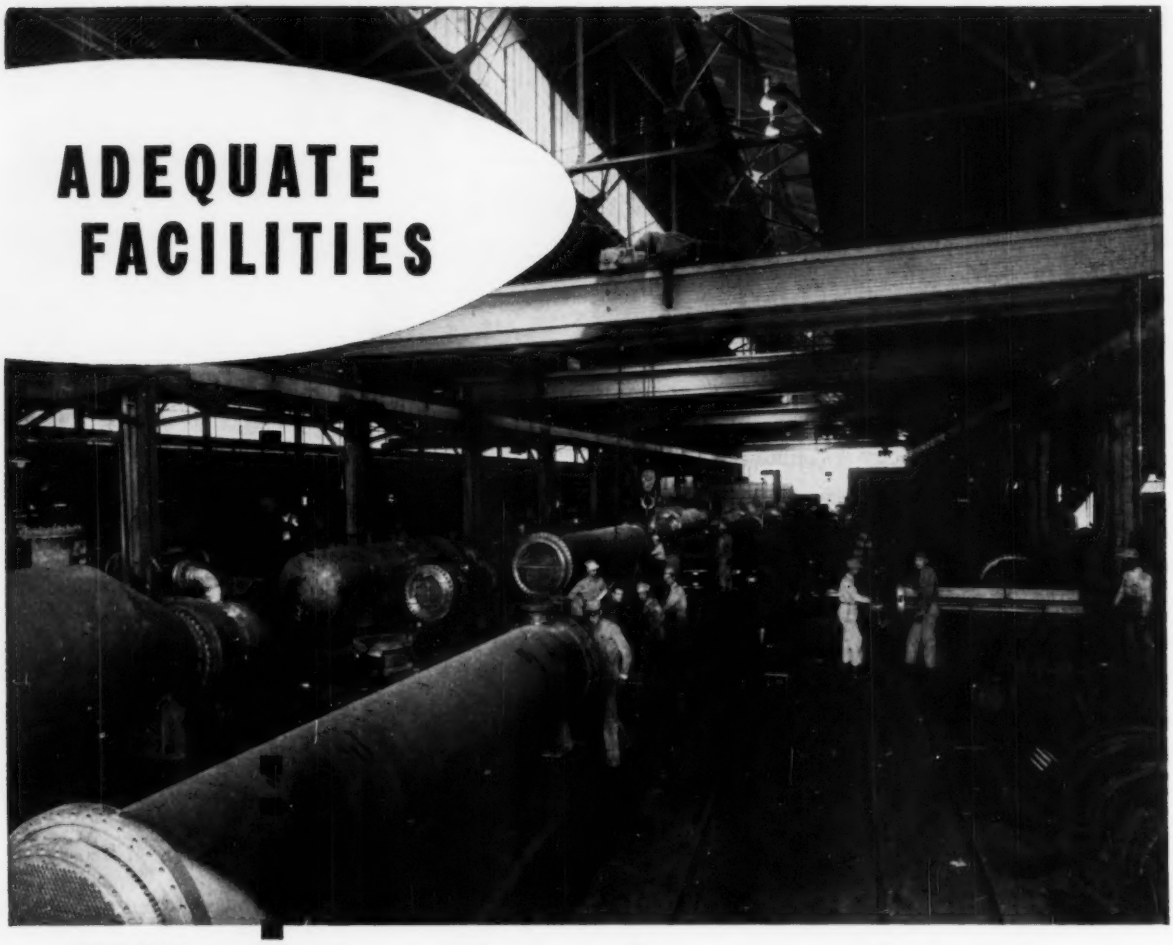
ADEQUATE FACILITIES



EFCO's Four Point Program Provides:

- service-proved engineering design
- guaranteed job ratings
- complete fabricating facilities
- technical service before, during and after installation

One reason that Efco does it *right* is its many years of experience in designing and fabricating heat-exchangers for the wide range of temperatures and pressures represented by ethylene plants and platinum catalyst reforming units. We are recognized specialists in handling all grades of carbon, alloy, and stainless steels, nickel, aluminum, and special low-temperature materials.

ASK OUR GULF COAST CUSTOMERS — THEY KNOW US WELL

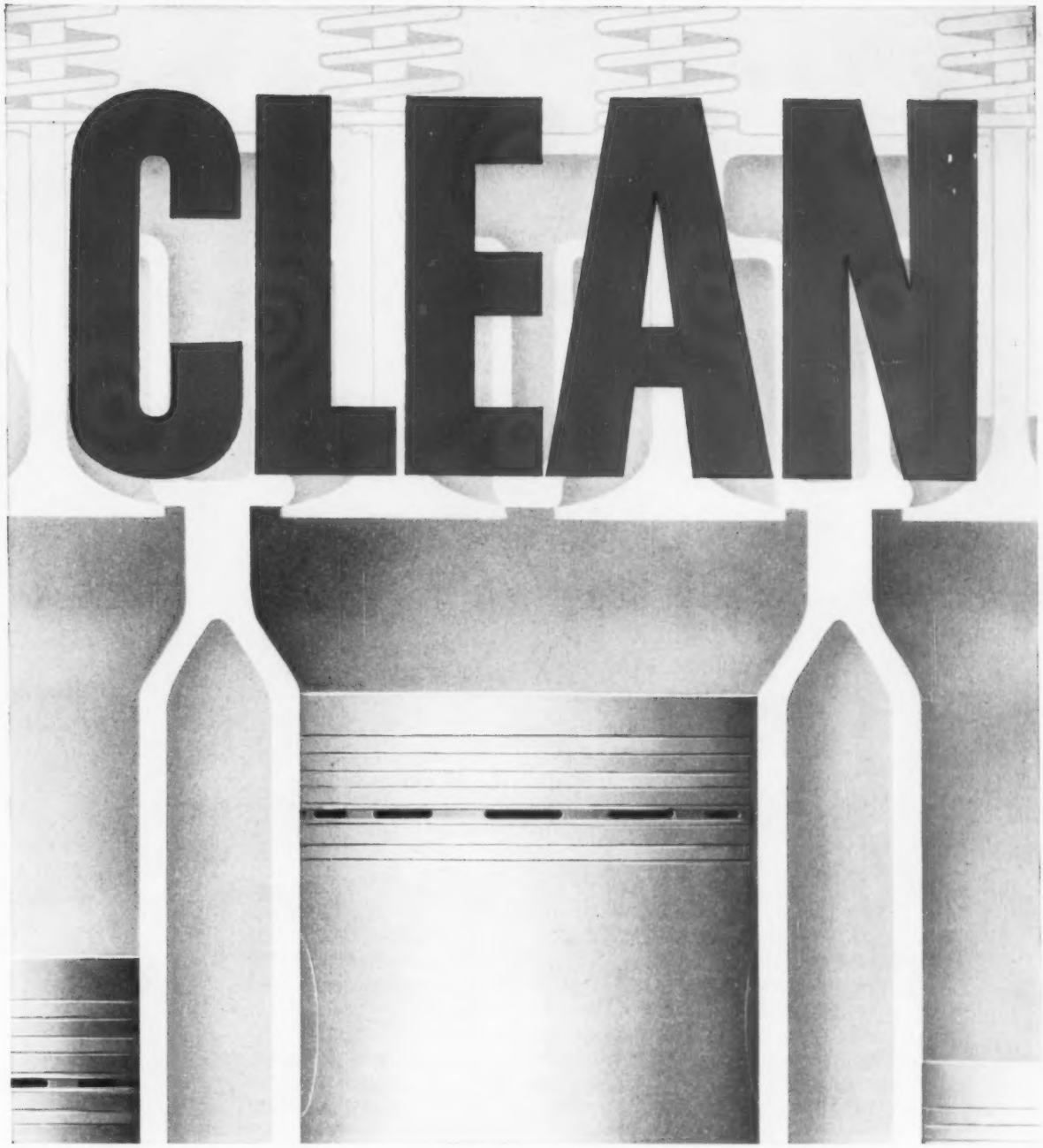
Write for General Catalog

EFCO HEAT TRANSFER EQUIPMENT

Engineers and Fabricators, Inc.

P. O. BOX 7395 **HOUSTON 8, TEXAS**

EFCO



PARANOX-BLENDED OILS HELP KEEP ENGINES CLEAN!

Ordinary lubricating oils take a beating in big, hard-working heavy-duty engines. High temperature, open-throttle operation causes hard varnish formations and oxidation breakdown. Low-temperature, short-period use causes wet sludge and deposits. Oils blended with *Paranox*® stay *clean* and *lubricate* at *all* temperatures for better performance and longer periods between overhauls.

Enjay has developed the *only complete line* of high quality additives (Paramins®). To meet the most exacting lubrication specifications, insist on Enjay Paramins.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 West 51st St., New York 19, N. Y. - Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

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. . . DRY JET FUELS

Jet aircraft now get a new and wider safety margin when their fuels are dried with LINDE Molecular Sieves. Even at high fuel flow rates, water normally absorbed at ground level is reduced to less than 10 ppm—eliminating ice-blocked fuel lines at high altitudes.

Liquids never before dried successfully by desiccants can now be dried commercially with these new zeolite adsorbents. Examples are acetone and other ketones, ethanol and other alcohols, and most saturated and unsaturated hydrocarbons. Drying to less than 1 ppm is now practical in dynamic systems. Due to their high water adsorbing capacity, LINDE Molecular Sieves bring pronounced savings in investment and operating costs.

No matter what the liquid—whether attempts to dry it have succeeded or failed—we would like to discuss with you what a Molecular Sieve design can do. Write Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde UNION CARBIDE

"Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation.

ACCO
for Better
Values

R-P&C VALVES

THE COMPLETE LINE
—DESIGNED FOR DEPENDABILITY

R-P&C "Sure-Tight" LUBROTITE GATE VALVES

—THE MULTI-SERVICE VALVES LUBRICATED THROUGH THE SEAT RINGS

Lubrotite Gate Valves—created and patented by R-P&C—are built to provide absolute tightness and long, trouble-free service in handling all fluids for which iron and cast steel valves are serviceable.

By the unique Lubrotite system, in which each seat ring is served by a Lubrotite gun, a lubricant seal is forced through to the valve's seating surface. This lubricant prevents leakage, retards corrosion, prevents sticking, reduces wear on seating surfaces and makes for easier operation. Net result: reduced operating, maintenance and over-all valve costs!

Available in cast steel and iron types. A wide variety of lubricant seals, each suitable for numerous services, can be furnished.

Lubrotite Gate Valves are giving highly successful service in handling—

Gasoline...Oil...Benzol...HF Alkylation... other Petroleum Derivatives —

Natural and Artificial Gas...Air... Helium Gas...Coke and Gas...Water —

Vacuum Service (evaporation, etc.)... Feed Water Lines and Steam Plants —

Mine and Acid River Waters... Certain Chemicals...Other Services

Lubrotite Gate Valves form a part of the complete R-P&C line, which includes gate, globe, angle and check valves in all standard materials; all in a wide range of sizes, styles and pressure classes. Order through nearby R-P&C Distributor. Write our Reading office for catalog.

FREE WALL CHART
"How to Protect Your Valves"
Installation pointers, operating tips, clues to longer valve life. They are all on this 22" x 17" wall chart. Write for your free copy.

R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

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ACCO

ROYAL PRECISION

LGP-30

Twice the capacity of any computer in its class... easiest to program in basic machine language... lowest in cost

With the compact, powerful LGP-30, you can obtain peak operating efficiency through on-site linear programming... can save substantially on every barrel produced by faster, simpler selection of (1) optimum-level production, sale and purchase of gasoline, butane, naphtha etc.; (2) severity level of the catalytic reformer; (3) tetraethyl lead content.

Because the LGP-30 is mobile, you can now have high-speed electronic computation *wherever you need it.* Operating from any convenient wall outlet, the self-cooled LGP-30 gives you memory (4096 words) and capacity comparable to computers many times its size and cost.

The lowest-priced complete computer you can buy, the LGP-30 has been so simplified that even non-technical personnel quickly grasp its operation. A library of sub-routines and programs is maintained — as well as an active users organization. Service facilities are available coast-to-coast.

Gives you optimum level efficiency in production, sales, purchase!

Other important jobs now being assigned to the LGP-30 in numerous petroleum installations include the following: pipeline problems; mass spectrometer calculations; analysis of oil field production; flash point calculations; pumping and batching scheduling; correlation of seismic records; reservoir engineering studies; well-logging interpretations.

ROYAL McBEE

data processing division

For further information and specifications, write Royal McBee Corporation, Data Processing Division, Port Chester, N.Y.

International Petroleum Exposition

5th World Petroleum Congress

TULSA, OKLA.
May 14-23

NEW YORK, N.Y.
May 30-June 5

Portion of
Tretolite division exhibit.

DON'T MISS THE TRETOLITE EXHIBITS AT THE 1959 IPE AND WPC SHOWS

SEE...

■ ***Animated water flooding exhibit*** that demonstrates *how* FLUDEX* Water Flood Additive can help stimulate well injectivity.

■ ***Model TRETOLITE* Desalter.*** (Its "big brothers" are now removing salt in the 98-100% range.)

■ ***Animated demonstration*** of KONTOL* Corrosion Inhibitor "squeeze treatment"

■ ***Molecular models*** of treating chemicals.

■ ***PLUS many other displays*** designed to explain how Tretolite products and processes work.

LEARN...

■ ***How*** the new TOLAD* Fuel Additive is providing long storage stability at low cost!

■ ***How*** KONTOL* Corrosion Inhibitor applications are cutting dollars from refinery costs—for pennies in treatment.

■ ***How*** emulsions are formed, what they are and how they can be resolved.

■ ***About*** the KONTOL* Corrosion Inhibitor "squeeze treatment". Animated flow diagram shows this application gives long term protection.

■ ***All about demulsification***—its history, early-day problems and the development of TRET-O-LITE* chemical treatment.

ALL THIS AND MORE await you in pleasant, air-conditioned surroundings.

WHERE TO FIND US...

IPE: The Petrolite Building. West side of Drumright Ave., just north of Scientific and Technical Bldg. (East half of Block U.)

WPC: Booth No. 97, 1st Floor, Coliseum.

Many of our field staff, research and administrative personnel will be on hand to welcome you—and discuss your special interests and problems.

Plan now to visit this informative exhibit!

*Registered trademarks of Petrolite Corporation

TX-59-1

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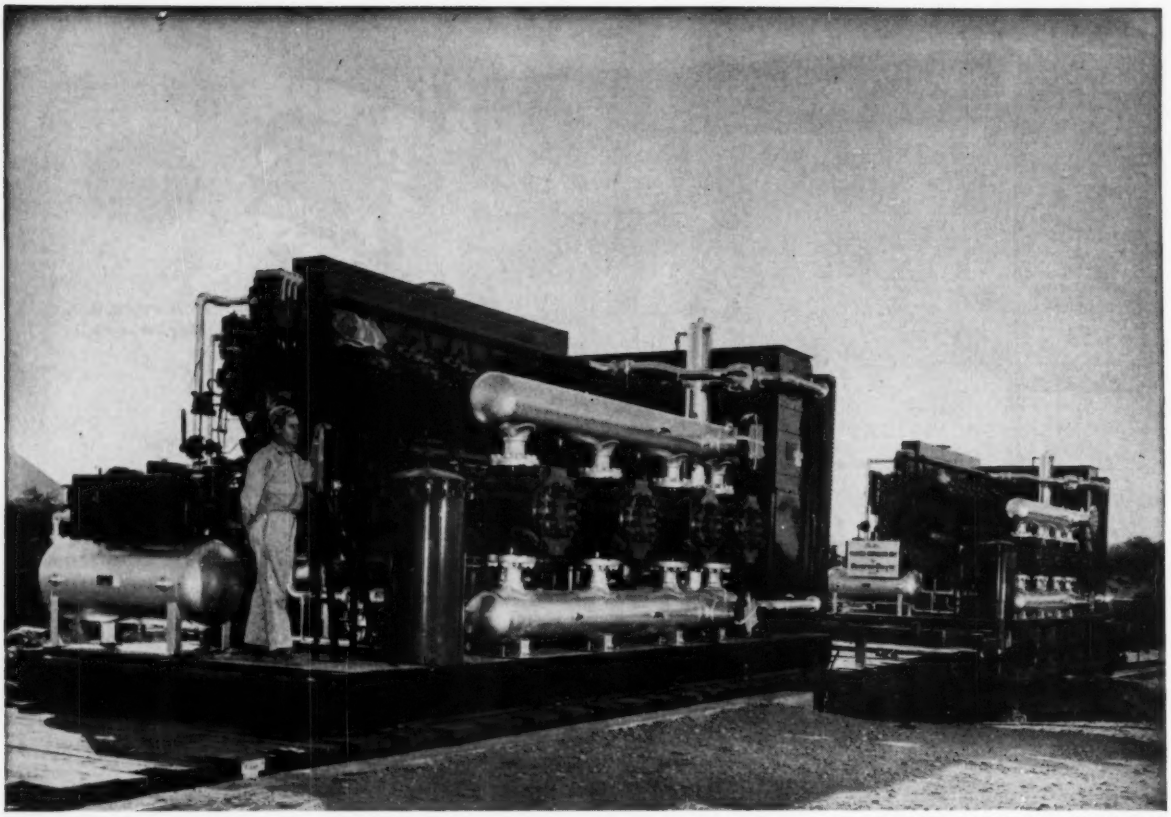
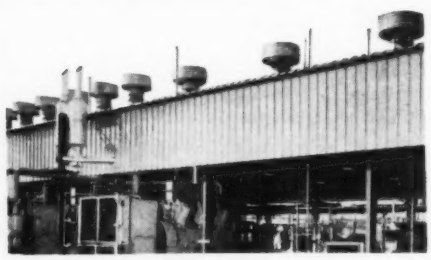


660 HP UNITS EN ROUTE TO MIDWEST

"just like the BIG ONES"

Each Stearns-Roger Packaged Compressor Plant is engineered and built like a main-line compressor station, matched to present and anticipated field conditions as well as problems presented by each installation. Every unit gives you choice of compressor and auxiliary equipment, proven Stearns-Roger engineering and assembly, installation, initial operation and checking by Stearns-Roger service personnel, and prompt delivery.

Each plant is packaged for transport in one unit, by rail or highway, ready for connection and start-up immediately upon arrival. Where gases of any type must be compressed, these Stearns-Roger plants offer the lowest installed cost per horsepower.



WEST COAST INSTALLATION

Write for our brochure: Packaged Compressor Plants

Stearns-Roger

THE STEARNS-ROGER MFG. CO. • DENVER, COLORADO

DENVER • HOUSTON • EL PASO • SALT LAKE CITY
STEARNS-ROGER ENGINEERING COMPANY, LTD., *Calgary, Alberta*
ENGINEERS • CONSTRUCTORS • MANUFACTURERS

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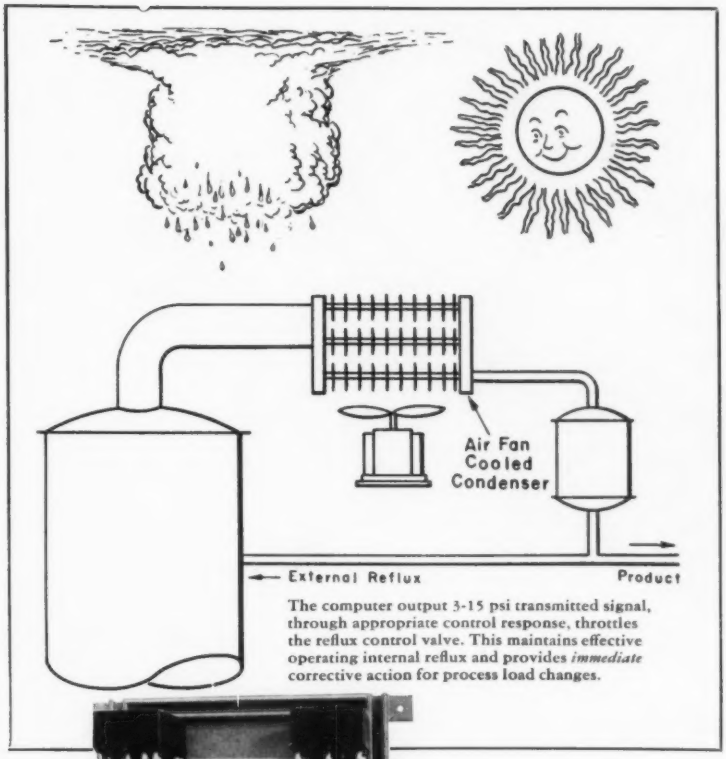
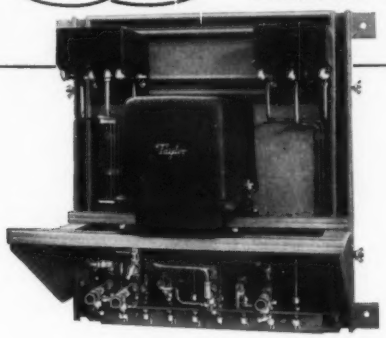


The computer output 3-15 psi transmitted signal, through appropriate control response, throttles the reflux control valve. This maintains effective operating internal reflux and provides *immediate* corrective action for process load changes.



FOR CONSISTENT COLUMN EFFICIENCY

...rain or shine

New Taylor Computer Control System Used by Phillips Petroleum Company

PROBLEM: Column upsets, caused by wide variations in load on the condenser due to changing weather conditions. Efficiency is reduced . . . more steam than necessary is used in reheating excessive reflux.

SOLUTION: A simple Taylor Computer Control System which instantly compensates for climatic effects on air-cooled condensers and reflux lines. This system is developed by and is licensed by Phillips Petroleum Company.

RESULTS: Phillips is delighted with the outstanding performance of this system, in commercial use on many columns. Phillips' engineers like its simplicity, and the fact that components are of the standard type with which its instrument people are accustomed. Here are some of the advantages of the Taylor Computer Control System:

1 It reduces steam consumption by the avoidance of reheating excessive reflux. The system pays for itself in a few months.

2 It provides more uniform products by smoothing out upsets at their source—particularly important on a battery of columns.

3 Not only does it give vastly improved control on columns utilizing air-cooled condensers (without the need for adjustment of air flow rate), it also pays out with other types of condensers.

4 It reduces the possibility of column flooding.

* * *

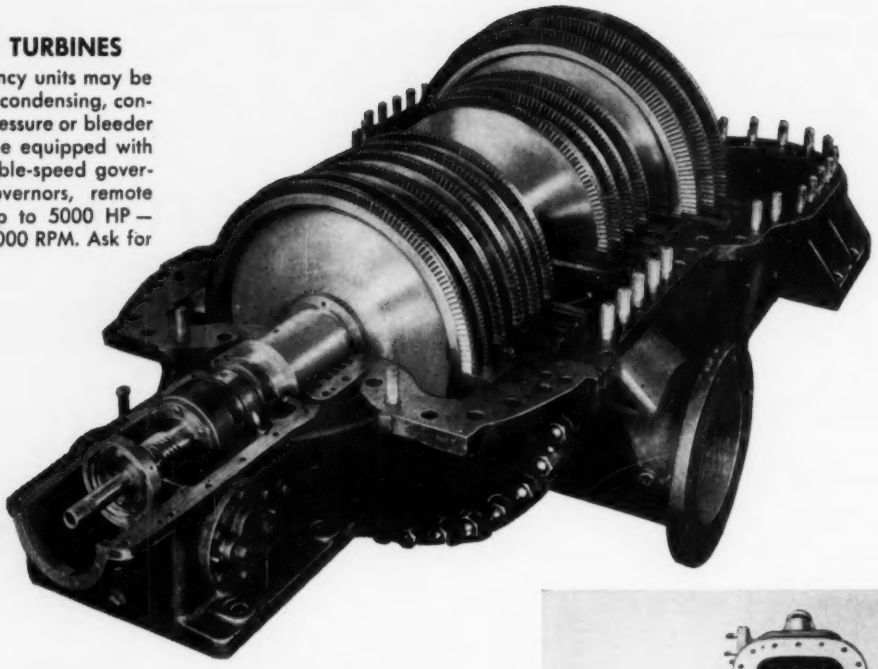
Call your Taylor Field Engineer today, or send for literature. Taylor Instrument Companies, Rochester, N.Y., or Toronto, Ontario.

Taylor Instruments **MEAN ACCURACY FIRST**

For more data on advertised products, use Readers' Service Cards, last page.

MULTI-STAGE TURBINES

These high-efficiency units may be designed for non-condensing, condensing, mixed pressure or bleeder operation. Can be equipped with constant or variable-speed governors, special governors, remote controls. Sizes up to 5000 HP — Speeds up to 10,000 RPM. Ask for Bulletin S-146.



There's a **Terry turbine** for every mechanical-drive requirement

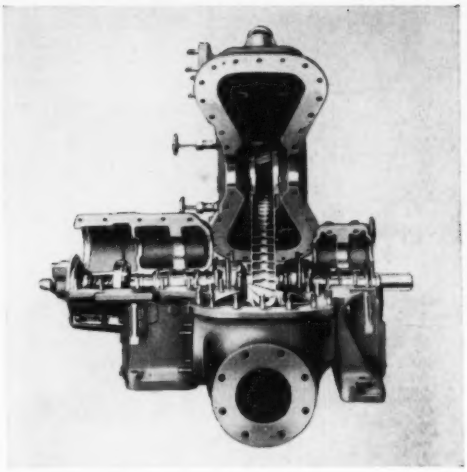
The designs for Terry turbines are based on more than 50 years of successful experience in the manufacture of turbine drives *exclusively*. This specialization has resulted in Terry becoming one of *the leading producers* of mechanical-drive turbines in sizes up to 5,000 horsepower.

There are three basic reasons why Terry has been able to maintain this position of leadership: (1) a thorough knowledge of the requirements of mechanical-drive turbines, (2) a willingness to build "a little something extra" into each machine to assure trouble-free operation, and (3) an acknowledgement of the company's responsibility to stand behind the performance of every turbine sold.

These are also the reasons why you should consider a Terry turbine for your next mechanical drive. In the meantime, send for bulletins describing any of the types of machines illustrated.

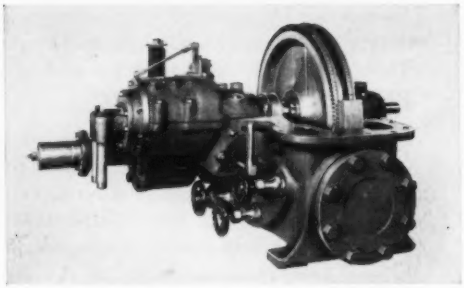
THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



SOLID-WHEEL TURBINES

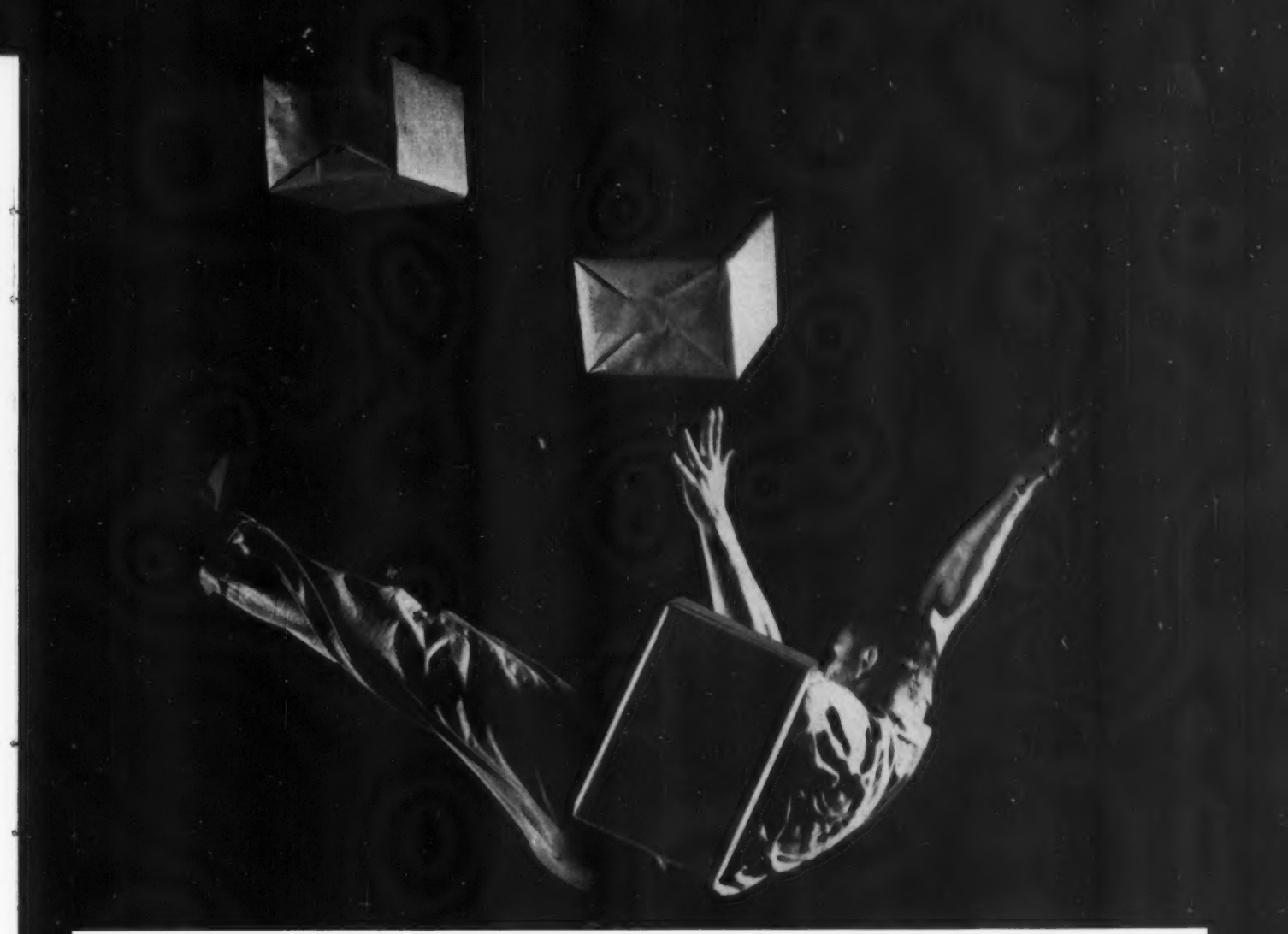
Famous for sure dependability and ease of inspection. Can be started cold — no preliminary warming required. Available in vertical designs depending on frame size. Capacities from 5 to 2,000 HP. Described in Bulletin S-116.



AXIAL-FLOW IMPULSE TURBINES

Built with one, two or three rows of high-grade stainless steel blading, these turbines combine efficiency with durability. Available in designs for moderate and high steam pressure. Bulletin S-143.

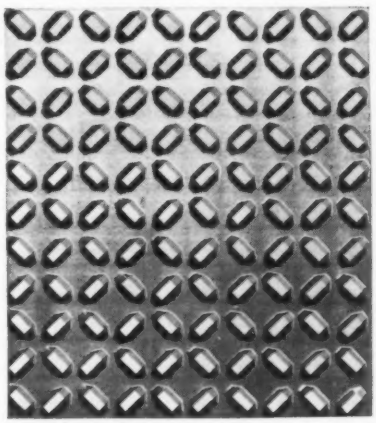
TT-1209



One slip can cost more than USS Multigrip

$100,000 for a single fall? Sounds fantastic, doesn't it? But there are actual cases involving suits for $100,000 or more for single falls. The average cost of injuries from slips and falls is lower than that, of course. In six states, during 1954, the cost per fall averaged close to $900.

You can eliminate many slips and falls by giving your workers a floor studded with cleats—USS Multigrip. This floor plate provides safe traction in any direction. The cleats are flat on top, easy to walk on—and do not catch the shoe.



For machine shops, loading platforms, cat-walks, and other dangerous locations, Multigrip supplies safety plus.

Where floors take a heavy beating from traffic, Multigrip will stand up for years under constant use. Oil and water won't soak in and can be easily removed from the surface with regular cleaning materials. You save money by having a floor that is easy to sweep or flush clean—and there's little or no maintenance.

On your next inspection trip, search out the danger spots—and make them safe with USS Multigrip.

USS is a registered trademark

Sold by leading distributors from coast to coast.

United States Steel Corporation – Pittsburgh
Tennessee Coal & Iron – Fairfield, Alabama
Columbia-Geneva Steel – San Francisco
United States Steel Supply – Steel Service Centers
United States Steel Export Company

United States Steel

for TANK FARM Inventory Control

"Varec" Pulse Code

DATA GATHERING AND REDUCTION SYSTEM

For handling such variables as LIQUID LEVEL *(in feet, inches and eighths; metric in millimeters or feet and hundredths)*; TEMPERATURE *(one degree increments to three digits)*; PRESSURE *(three digits in one or ten pound increments)*; FLOW VOLUME *(to five or six digits in one or ten barrel increments or other volume units)*. The system will also log the status and provides for the control of operating equipment such as valves, pump motors, etc. Time data and identification points can be recorded as needed to suit the operation. Flexibility is one of the system's outstanding features since it allows the use of standard proven systems for custom applications that would otherwise require special-built, untested units.

FLEXIBLE ARRANGEMENT

Almost any type of logging program can be arranged by using standard sub-assemblies: Logging on prearranged form, with or without point identification, or on random order basis with point identification •••••• Entry of one or more lines of data for log cycle •••••• Time entry at start of each line entry. All numbers, fractions and letters available for logging; carriage shift; black-red ribbon shift provisions.

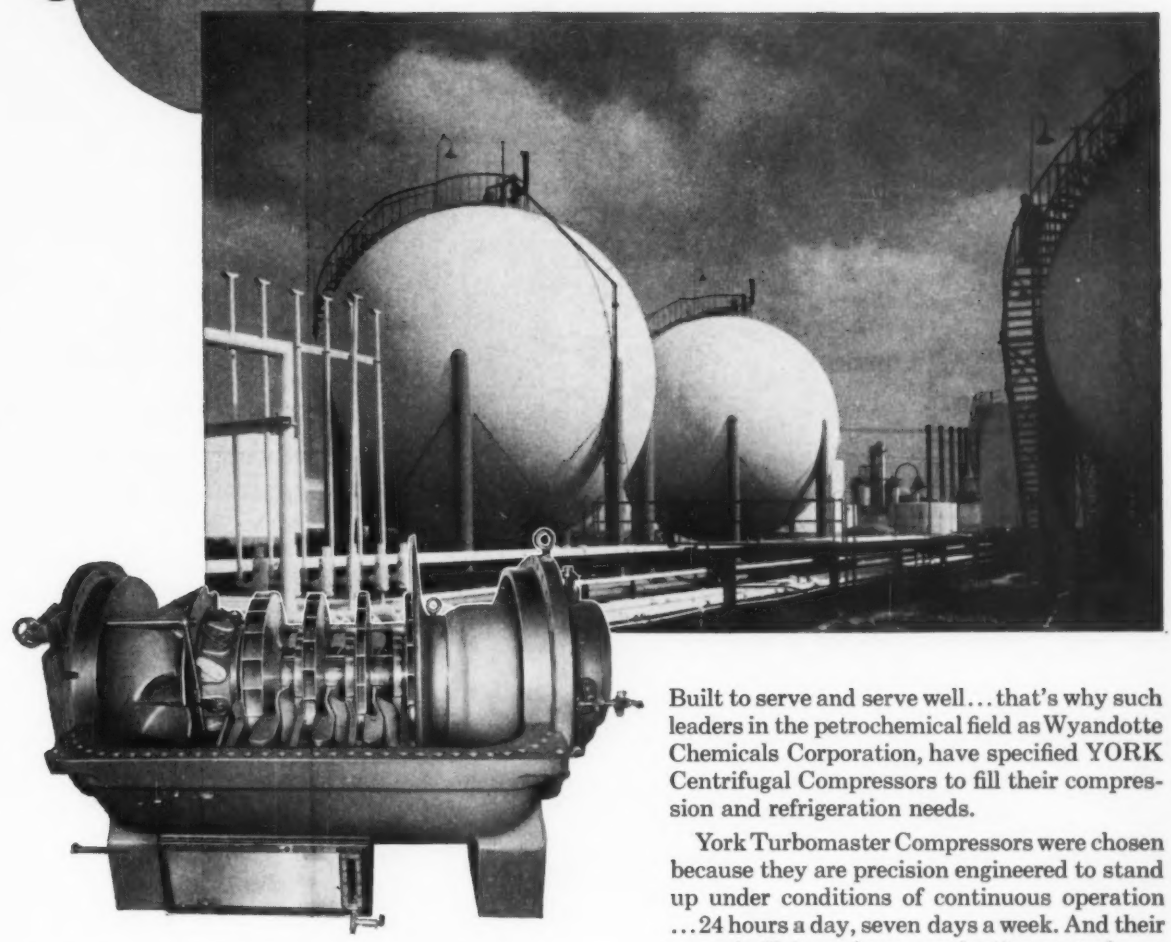
FLEXIBLE OPERATION

Manual operation without Data Logging by means of a telephone dial which obtains a visual indication of any point included in the system ••••• Manual control of Scanning-Logging Cycle can be started at any time by the operator at any desired point ••••• Automatic Control of Scanning-Logging Cycle can be initiated on a time programmed basis by time clock control.

FOR A COMPLETE ENGINEERING APPROACH TO TELEMETERING SYSTEMS REQUEST PACKAGE 24

THE VAPOR RECOVERY SYSTEMS COMPANY • COMPTON, CALIFORNIA

Look Inside THIS GAS PROCESSING PLANT TO SEE HOW YORK MULTI-STAGE CENTRIFUGAL TURBOMASTERS SERVE THE PETROCHEMICAL INDUSTRY



1. Simplified Compressor Has 400 Fewer Parts
2. Precision Bearing Fit Without Scraping
3. Patented Lightweight Shaft Coupling
4. Casing Stays Tight at Highest Pressures
5. One-Piece Oil Pump Eliminates Gears, Motor
6. Bearing Loads Reduced Due to Short Shaft
7. Shaft Seal Replaceable Without Removing Gas
8. Prerotation Vanes Give Accurate Capacity Control

Built to serve and serve well... that's why such leaders in the petrochemical field as Wyandotte Chemicals Corporation, have specified YORK Centrifugal Compressors to fill their compression and refrigeration needs.

York Turbomaster Compressors were chosen because they are precision engineered to stand up under conditions of continuous operation ...24 hours a day, seven days a week. And their rugged efficiency keeps production costs down, output up.

So look inside York Multi-Stage Turbomaster Compressors and see why they are ideally suited for use in catalytic cracking, gas compression, lean oil cooling, dewaxing, and for low temperature applications.

YORK

YORK CORP. SUBSIDIARY OF BORG-WARNER CORP.

BORG-WARNER RESEARCH & ENGINEERING MAKE IT BETTER

Air Conditioning, Heating, Refrigeration and Ice Making Equipment • Products for Home, Commercial and Industrial Installation

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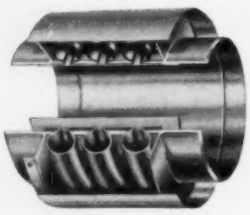
NEW ZALLEA HyPTor* TOROIDAL EXPANSION JOINT



HyPTor corrugations have a circular or toroidal cross section which provides a lower operating stress at any given pressure than any other corrugation shape.

For unequalled endurance at pressure and temperature extremes

This unique toroidal expansion joint with thin-walled bellows is setting new performance and durability records in high pressure, high temperature service. It was developed to meet the severest operating conditions without sacrificing long life.

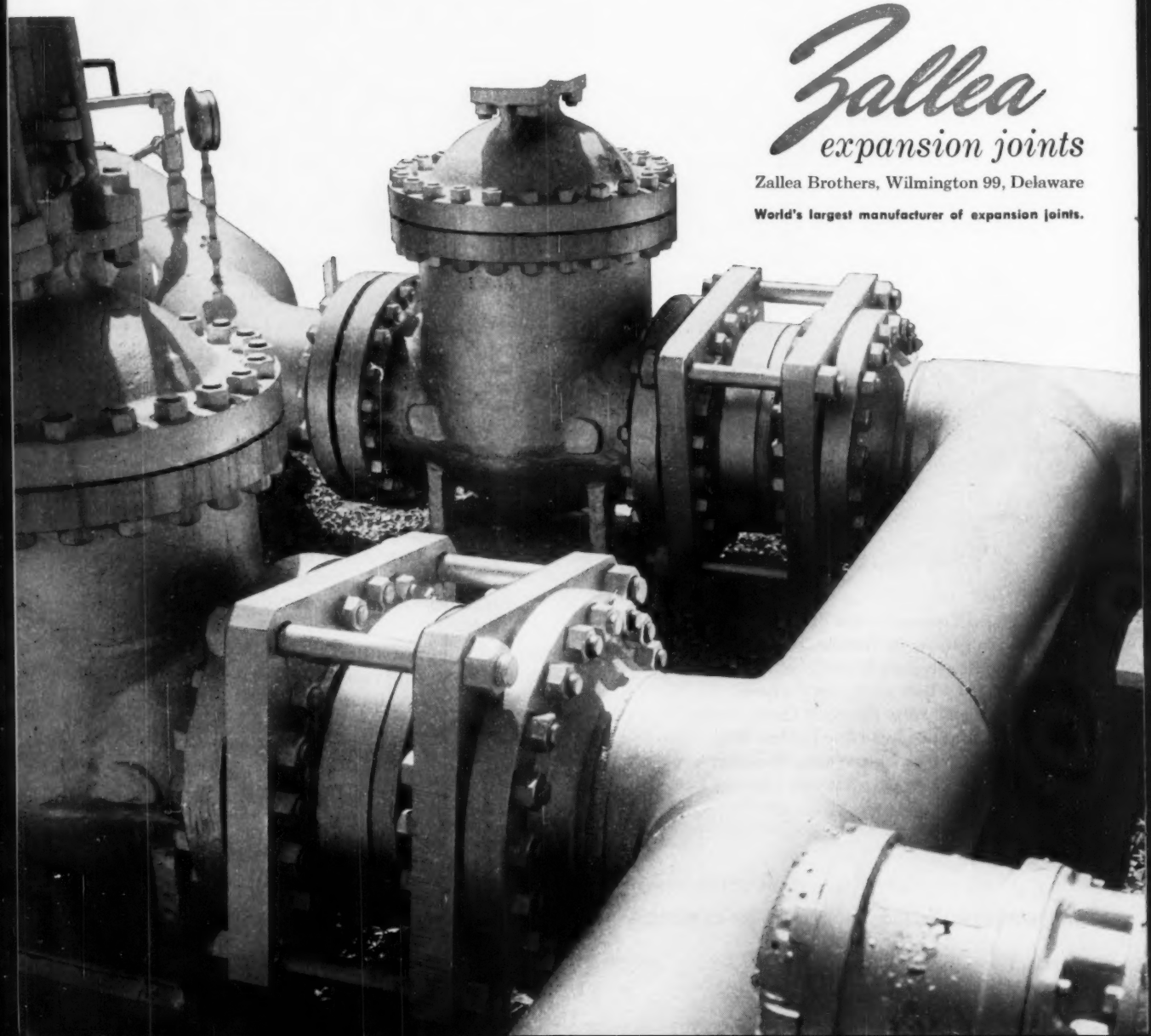
Minimum stress at high pressures is one advantage of the Zallea HyPTor. This is due to the thin-walled bellows and toroidal corrugations. Thin walls develop lowest flexing stress. The toroidal cross section assures lower operating stress at any pressure.

Superior performance at high temperatures. The toroidal corrugation of the HyPTor makes it suitable for use at high temperatures. Also, the HyPTor is hydraulically formed and free from circumferential welds which would act as stress raisers.

Longer life on the job. The ability of the HyPTor to absorb punishment without ill effects has been proved in service. A number of HyPTor Expansion Joints designed for 700 psi working pressure, were installed in liquid oxygen service in 1948. They are still operating . . . at pressures up to 2300 psi.

Get the complete story of the new Zallea HyPTor Expansion Joints. Our new 72-page Expansion Joint Manual gives full details—plus worthwhile information on basic types, design and installation data, expansion joint selection and recommended specifications. Write on your Company letterhead, for your free copy of Catalog 56, Zallea Brothers, 890 Locust Street, Wilmington 99, Delaware.

*Patented

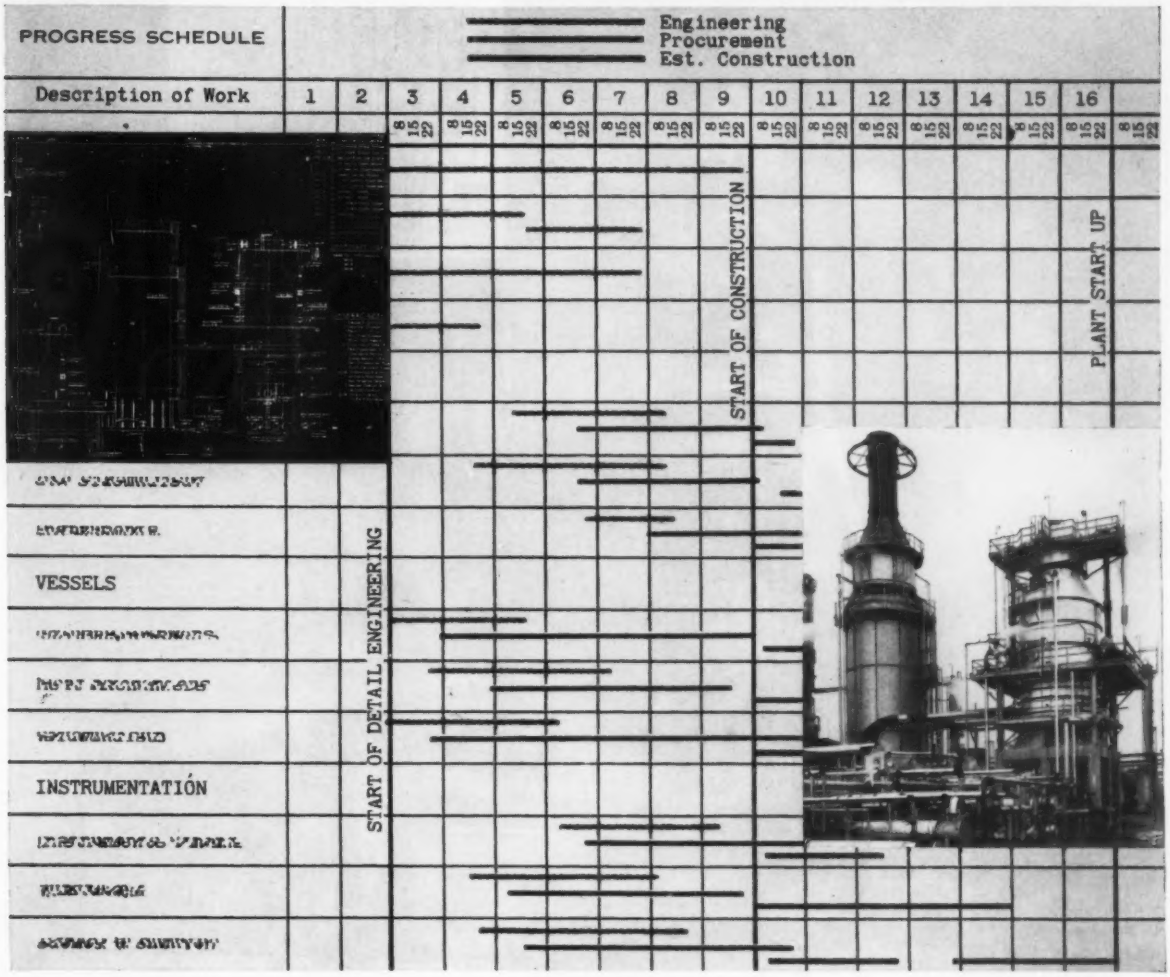


Zallea
expansion joints

Zallea Brothers, Wilmington 99, Delaware

World's largest manufacturer of expansion joints.

Blaw-Knox builds vacuum unit for Ashland Oil.
Located at Canton, Ohio, this unit processes 15,000 barrels a day . . . proficiently reduces carbon content in cat cracker feedstocks . . . boosts overall refinery capacity.



From plans . . . to scheduling . . . to operation integrated construction pays off three times in two years

By placing this vacuum unit on stream on time, Blaw-Knox completes its third project for Ashland Oil and Refining Company. Within the past two years Blaw-Knox has also engineered and constructed two catalytic reforming and hydrogen desulfurization units for this expanding company. Each of these units was producing at capacity, on schedule, and within the budget requirements.

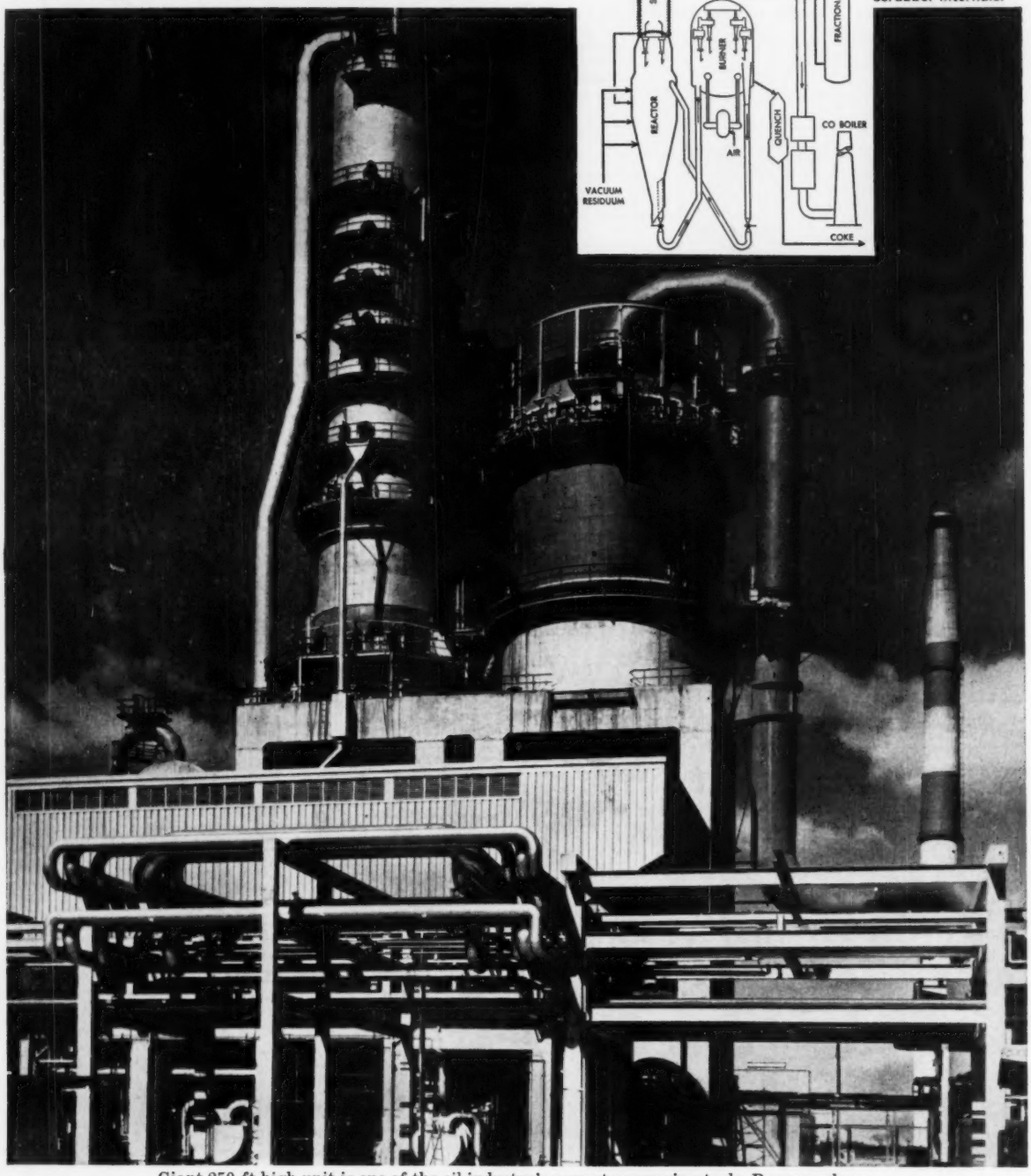
Blaw-Knox prizes its repeated association with many of the country's leading processing companies. For repeat business demonstrates as no other way can, the continuing endorsement of the technical background and engineering skill of this contract management organization.

Bulletin 2547 provides a graphic description of the erection, expansion, and modernization services for petroleum processing plants. For your copy, contact Blaw-Knox Company, Chemical Plants Division with headquarters in Pittsburgh. Branch offices in New York, Chicago, Haddon Heights, N. J., Birmingham, Washington, D. C., and San Francisco.

for plants of distinction . . . BLAW-KNOX

For more data on advertised products, use Readers' Service Cards, last page.

Tidewater Fluid Coker continuously cracks 42,000 bpsd of vacuum tower bottoms



Cross-hatching indicates 18-8 stainless-clad steel. Solid 18-8 stainless is used for scrubber internals.

Giant 250-ft high unit is one of the oil industry's newest processing tools. Burner releases 400 million BTU per hour. This heat is transferred to the reactor through coke circulation.

18-8 Stainless Steel protects giant coker

Diagram shows where Nickel-containing stainless steel combats corrosion in this unit. The principal corrosive is hydrogen sulfide in both liquid and vapor phases. Temperatures go up to 800°F. To keep your equipment on stream longer consider chromium-nickel stainless steels wherever conditions like this exist.

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To The Editor:

Thank you very much for your recent letter advising that you have decided to publish my article "Hose Drying Rack in Bridge Form." Your kindness regarding my contribution is very much appreciated.

Over the past two years you have published several of my contributions either as technical reports or "How-To-Do-It" items.

Last year I used the total amount of honorariums paid to me to purchase a complete Hi-Fi phonographic system and a number of selected records. This equipment was shipped to me from a friend in New York and now the music in my home gives me and my family great enjoyment each night.

The attached photograph shows my daughter Shun-In, five years old, sitting by the speaker. You will notice the words "Petroleum Refiner" which I sewed on the surface cloth of the cabinet. This will express our thanks to PETROLEUM REFINER for your many courtesies and our appreciation for the music that we enjoy every day through your instrumentality.

Tzen-Yung Yang
Maintenance Department
Kaohsiung Refinery
Kaohsiung, Taiwan

Shared in Project

To the Editor:

The feature section of "Who's Building," February, 1959, PETROLEUM REFINER, carried a lead story about the second-stage gas processing plant at Lacq. Reference was also made to the third-stage plant.

This article prominently features the activities of Foster Wheeler and to a lesser degree reference is made to the sulfur plants engineered by Parsons. It completely fails to mention Hydrocarbon Research, Inc., and its French affiliate, Hydrocarbon Engineering S.a.r.l. . . .

All the low temperature facilities in the second and third-stage plants for the separation, purification and recovery of higher hydrocarbons and the delivery of dry gas to the pipeline, are covered by contracts with our two companies.

We are also engaged in a third contract with SNPA covering the design, engineering, supervision of construction, supervision of initial operation of a plant to manufacture ethylene from ethane which we will separate in the above mentioned facilities.

E. T. Layng
Vice President
Hydrocarbon Research, Inc.
New York City

Real Contribution

To The Editor:

We have read with utmost interest the article in your November, 1958 issue (Page 329) entitled "How Du Pont Handles Alcoholics" in that it offers a practical approach for the treatment of this problem. Inasmuch as our magazine, Frontera, is devoted to the industrial development of Mexico (although the oil industry takes first place) and knowing that alcoholism is prevalent amongst our workmen and takes a rather heavy toll, we would like permission to translate the article for use in a forthcoming issue.

You may be sure that by granting us permission you would be contributing considerably toward the treatment and possible solution of something that has been a more than painful thorn in the side of Mexican industrialists.

Alfonso Bravo R.,
General Manager, "Frontera"
Mexico, D.F.

Editor's Note—*Permission was granted. This article by Gerald M. Gordon and Dave "M" has had wide acceptance, the reprint demand being tremendous.*

Errata

The programs of the Twenty-fourth Midyear Meeting of the American Petroleum Institute Division of Refining and that of the Fifth World Petroleum Congress became mixed and resulted in some confusion to readers of Page 258 of PETROLEUM REFINER's March issue. The first two columns on that page did deal with the API as labeled but column three presented a list of topics scheduled for the WPC and should have been so designated.

API Division of Refining dates for New York City are May 27-29. Sessions will be held three days this year instead of the customary four. Also, the meeting this year is late in the week rather than starting on Monday, this plan being adopted in order to complete a tie-in with the World Petroleum Congress, also in New York, its dates being May 30-June 5. See Page 254 of this issue for details relating to the World Petroleum Congress program.

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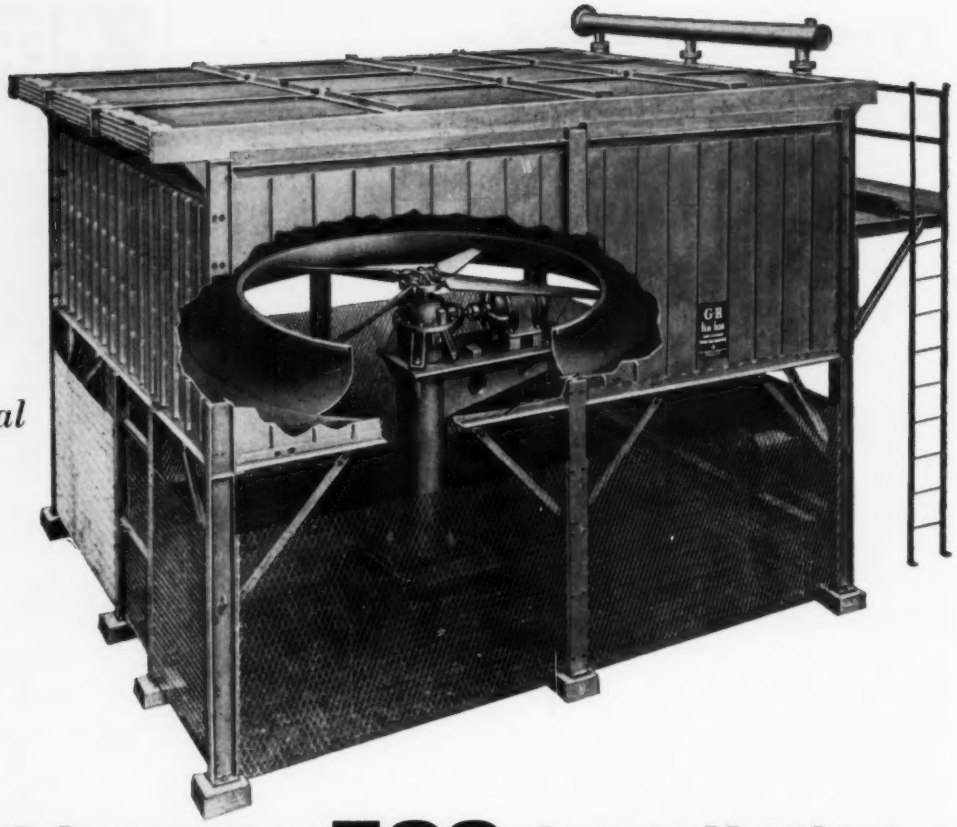

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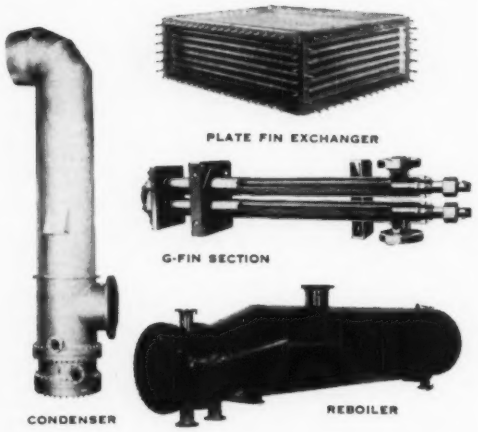

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GR 380

A PETROLEUM REFINER Special Report

Air-Cooled Heat Exchangers

AIR COOLING is making a strong bid for application in the refining, petrochemical, and natural gasoline industry. Here is a PETROLEUM REFINER Special Report which will help you answer questions about this equipment.

Air-cooled heat exchangers already have found wide acceptance in places where water cooling is either impossible or impractical. Now refiners are learning air may be the better coolant even in cases where water is plentiful.

Cost is the deciding factor. It is usually better to use air when condensing temperatures are high. Nevertheless, the choice between air and water is not always obvious, and studies are required to point up the differences in costs.

There are five articles in this Special Report. They discuss: cost comparisons for some typical air cooling uses, a check list for specifying the equipment to a vendor, some pointers for design, and useful tips on how to field test air cooler installations.

You can expect to see more use of this type of equipment in the future. Here is your chance to keep up-to-date.

Harold L. Hoffman
PROCESS AND CONSTRUCTION EDITOR

Which Cooling Medium—Water or Air?

The better cooling medium for various applications is not always obvious. Before making your selection, look over these cost data

Bob C. Perkins
Celanese Corporation of America
Pampa, Texas

WHEN SELECTING condensing equipment the first question which must be answered is: "Which cooling medium should be used—water or air?" In the past this choice rarely was considered since the selection of water was almost second nature. Now, however, consideration should be given to the economics of both routes.

Water in many areas has become a precious commodity because of the rapid growth of petrochemical and refining industries. The air-cooled exchangers then are answering this and other problems in a number of plants.

Air-cooled exchangers are not the cure-all because the over-all economic picture may not point to the air-cooled exchanger as being the better, even where cooling water is expensive. In addition to initial equipment costs, operating costs must be considered since the low price tag does not tell the whole story. Only when both items are carefully considered can the design engineer make the most economical selection of equipment.

A number of factors are involved in selecting the better cooling me-

dium. Some of the more important ones will be discussed:

Coolant Supply. In the case of air-cooled exchangers, the coolant supply is available in unlimited quantities at any location. Water, however, may not be available in the quantity or quality required at the desired plant location. Rivers, lakes, and wells are the major sources of water for cooling tower make-up. River water is relatively inexpensive and may often be used on a once through basis, eliminating altogether the need for a cooling tower to permit reuse of the water. This is an ideal situation. Lake and well water is less plentiful and usually more costly, particularly the latter source. Furthermore, the cooling tower for reusing water becomes necessary. Where the water supply is inadequate, even for makeup, the air-cooled exchanger can be quite valuable. They make it possible to locate plants near raw material sources and shipping facilities. This is common in many of the western states.

Weather and Condensing Temperatures. Limitations on cooling tower approach, during the summer months, can be an important factor when condensing temperatures are low. Along the Gulf Coast, 90 F. dry bulb and 70 percent humidity are common. Assuming a minimum approach of 5 F. to wet bulb on the cooling tower, the cooling water temperature will be only 3 F. lower than the ambient air temperature. In hot arid areas, cooling water may be available as much as 25 F. lower than ambient air temperature. This would be true for example with 105 F. ambient air, 25 percent humidity, and a 5 F. approach.

If a condensation temperature of 120 F. is required, the use of air-cooled exchangers would be prohibitive with 105 F. air if 80 F. water were available. However, air could be quite competitive with water if the air were available at 90 F. and the water at 87 F. High condensing temperatures likewise are more favorable to air.

Just as it is important to predict cooling tower performance for water cooling, it is important to establish a practical maximum ambient air temperature for design of air-cooled units. This design point will depend on the location of the plant.

Installation Costs. Whichever cooling medium is selected, a number of items must be considered for each route. For water, the costs of cooling tower and basin, make-up water facilities, treatment equipment, cooling water circulating pumps and drivers, power supply,

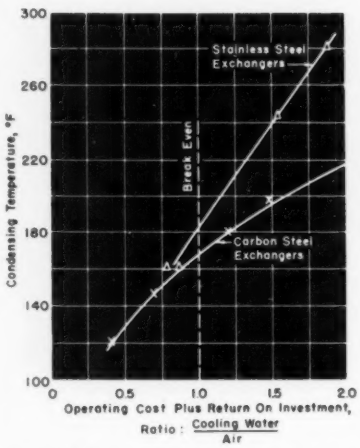

FIGURE 1—Usually air cooling is cheaper than water cooling when condensing temperature is high. This curve shows the break even point for two kinds of construction material.

necessary supply and return piping, blowdown facilities, and shell and tube exchangers contribute to this figure. For air-cooler units, the cost of fans, drivers, gear boxes, structure, power supply and exchanger bundles compose the installed cost. Consideration of all these items, as well as construction costs (foundations, contractor fees, etc.), is required for an accurate picture.

For a specific condensing service, installation costs for air-cooled exchangers will not necessarily be higher than shell and tube exchangers along with their pro-rata share of the cooling water facilities. For high condensing temperatures, the installed costs for water cooled units will usually be greater than for air units. This is because the size of the cooling tower and other related facilities is a function of the heat duty once the cooling water temperature range has been established. On the other hand, the upper limit to which the air can be heated is governed only by the temperature approach.

A given air-cooled unit may handle twice the heat load with a high condensing temperature than it will with a low condensing temperature. For a shell and tube exchanger to handle twice the duty requires twice as much cooling water. Therefore, the total cost of the complete cooling water set-up would be greater.

Conversely, a low condensing temperature increases the required surface area of both a shell and tube exchanger and an air-cooled unit. Since the pro-rata share of the cost of cooling water is a function of heat load, the over-all cost for the shell and tube installation will be relatively low. The cost of the air-cooled unit auxiliaries, structure, foundations, fans and drivers will increase proportionately with the surface area, making the total cost higher than the cooling water unit.

Water Treating Costs. Treatment of recirculated cooling water systems is a must. The degree of treatment varies widely with the problems, such as, excessive scaling in exchangers; corrosion of the exposed metal surfaces in the cooling water system; algea and bacterial growth; deposition of dirt, silt, and mud in exchangers; and exchanger leakage contaminating process material with cooling water or vice versa. Practically all sytems have one or more of these problems. Some are rather inexpensive to control while others may require extensive treatment and costly alloy materials. These problems and their solution contribute to the operating cost of cooling water systems.

Since these problems are not encountered with air-cooled exchangers, this one item—cost of treatment and personnel to administer it—could swing the economics in favor of the air-cooled unit.

Power Costs. As mentioned before,

the cost of cooling water facilities is basically a function of heat load while the air-cooled exchanger auxiliary cost depends (to a large degree) on condensing temperature. Therefore, a statement that power costs are greater for one route than the other cannot be made. Power requirements for water are: makeup water, circulating demands, and cooling tower fans. For the air unit, power is required to drive the fans. The over-all breakdown for Celanese's Pampa plant is roughly as shown in Table 1.

TABLE 1—Power Requirements

	Cooling Water System	Air Cooled Systems (Condensing and Sub-Cooling)
Heat Duty, Million Btu/Hr	350	613
Horsepower Requirements		
Makeup Water	200	.....
Fans	800	2,640
Circulation	800	.....
Total	1,800	2,640
Per Million Btu	5.1 (design)	4.3 (design)

For this specific plant, the actual power requirement per unit of heat duty for air-cooled exchangers is about 16 percent less than that required for the cooling water system. Individual services, however, vary quite widely as will be shown later.

Space and Location Requirements. Plot area required for condensing facilities can present a problem. Frequently space occupied by shell and tube exchangers is adequately supplied by normal spacing of fractionating towers and allied equipment. Air-cooled exchangers require considerably more space. However, by installing them above pipeways with the exchanger support as part of the pipeway support, any space problems can be greatly diminished if not eliminated. This may be desirable to reduce process piping costs, particularly where stainless steel overhead vapor lines are required, even where the space occupied by the air-cooler units is not critical. Therefore, with either air or water cooled exchangers, the exchanger itself will seldom present serious space or location problems.

The location of cooling tower and allied equipment may not be as easily solved. For minimum piping, the cooling tower should be located as near the fractionating towers as possible. However, fogging and misting can create poor working conditions nearby, particularly in winter months. Locations outside the operating area can present similar problems to public roads and private property.

Generally, the total land area will be larger for cooling water facilities than for air-cooled exchangers.

Maintenance Costs. A comparison of maintenance costs for the two routes usually shows a distinct advantage for the air unit. Repairs on drivers (electric or turbines), gear boxes and fans for the air-cooled exchangers are quite low. Any fouling and corrosion is confined to the process side of the exchanger.

For the water cooled units, in addition to the foregoing maintenance costs, there are additional costs due to fouling and corrosion on the water side of the exchangers, repairs to the cooling tower, treating equipment, makeup and blowdown facilities and circulating equipment. At Pampa, the maintenance on the air units, excluding corrosion or fouling due to process fluid, is about 30 percent of that for the cooling tower installation.

Blowdown Disposal. Disposal of cooling tower blowdown can pose a costly problem in certain areas. Main outlets for blowdown disposal are rivers, lakes and man-made ponds. If the river flow is small or intermittent, disposal of blowdown from cooling towers requiring extensive water treatment can present a hazard to wild life and domestic animals drinking the water.

Disposal to lakes for evaporation, of course, entails the expense of purchasing or leasing the land and transporting the stream. The same cost applies to man-made ponds plus cost of construction and possibly sprays to aid evaporation. The air-cooled exchanger is exempt from these problems.

Over-all Economics. The effect on economics of some of these factors, such as coolant supply, weather, space requirements, and blowdown disposal, is influenced largely by the type of plant and location. In the

TABLE 2—Compare Economics of Cooling Media

PRODUCT CONDENSED	ACETIC ACID		LOW BOILING ORGANICS		EXHAUST STEAM		METHANOL		METHANOL	
Cooling Medium	Air	Water	Air	Water	Air	Water	Air	Water	Air	Water
Quantity, Lbs/Hr	100,000		51,800		100,000		25,000		25,000	
Heat Duty, Btu/Hr	17,500,000		15,300,000		97,000,000		11,350,000		11,800,000	
Condensing Temp., °F	244		160		212		180		147	
Pressure, psig	0		0		0		15		0	
"U", BTU/(Hr) (°F)(Ft² Inside)	90	138	105	150	145	250	90	150	95	160
LMTD, °F	112	148	43	64	76	117	60	84	34	51
Inside Area Required, Ft²	1,730	850	3,400	1,600	8,800	3,320	2,100	900	3,660	1,450
Capital Investment, Dollars										
Cooling Tower (pro-rata share of a 10,000 gpm tower at $200,000)	.....	35,000	.....	30,600	.....	194,000	.....	22,700	.....	23,600
Exchangers Matl. of Construction	Stainless Steel		Stainless Steel		Carbon Steel		Carbon Steel		Carbon Steel	
Installed Cost	43,200	12,700	85,200	22,600	132,000	12,800	31,500	4,100	54,900	6,000
Total Capital Investment	43,200	47,700	85,200	53,200	132,000	206,800	31,500	26,800	54,900	29,600
Operating Costs (Annual), Dollars										
Cooling Water Makeup and Treatment ($0.005/1,000 Gal. Circulated)	.....	4,600	.....	4,000	.....	25,500	.....	3,000	.....	3,100
Power ($0.006/KWH)	2,400	3,700	4,700	3,200	12,200	21,600	2,900	2,400	5,000	2,500
Depreciation (7% on Exchangers)	3,000	900	6,000	1,600	9,200	900	2,200	300	3,800	400
(5% on Cooling Tower)	.....	1,700	.....	1,500	.....	9,700	.....	1,100	.....	1,200
Maintenance (1% on Air, 3% on Water)	400	1,400	900	1,600	1,300	6,200	300	800	500	900
Total Operating Cost per Year	5,800	12,300	11,600	11,900	22,700	63,900	5,400	7,600	9,300	8,100
Return on Investment (10% after Federal Tax at 50%)	8,600	9,500	17,000	10,000	26,400	41,200	6,300	5,400	11,000	5,900
Total, Operating Cost and Profit, Dollars	14,400	21,800	28,600	22,000	49,100	105,100	11,700	13,000	20,300	14,000

examples which follow, no attempt will be made to show their bearing on the over-all economics. Other items discussed, however, are more general and the effect of each can best be illustrated with typical examples.

Examples

The following cases are taken from our operating experiments:

- Condensing acetic acid
- Condensing low boilers (organic chemical mixture)
- Condensing exhaust steam
- Condensing methanol at 15 psig
- Condensing methanol at atmospheric pressure

Table 2 shows the cost of installation, cooling water makeup and treatment, power, depreciation and maintenance. In each case a 10,000 gpm cooling tower with 105 F. to 85 F. range is assumed. A cost of $200,000 for the tower, basin, circulating facilities, and treating equipment is assumed and a pro-rata share of this investment used in each example. A design ambient air temperature of 100 F. for the air-cooled exchangers is used. The costs for both shell and tube and the complete air-cooled units are taken from recent estimates from manufacturers.

Return on investment is included in each example. Profit after taxes must be realized for these capital funds required for the initial installation. Since capital requirements vary with the route chosen, and from service to service, some method of showing this profit should be used to obtain the true economic picture.

The effect of low air side heat transfer coefficient for air coolers is evident in each example. Even with extended surface on the outside of the tube, the over-all coefficient is usually less than for shell and tube exchangers in condensing service. Likewise, the lower cooling tower inlet and outlet temperature (20 F. rise) as opposed to the air is evident in the log mean temperature difference (LMTD). The inside surface area for both types of exchangers is used for easier comparison of the size of the units.

Acetic Acid. Condensing acetic acid at atmospheric pressure requires stainless steel exchangers. The total capital investment for cooling water is only slightly higher than air. However, the operating cost for air is less than half that for water. This is due mainly to the relatively high condensing temperature of acetic acid. The economics are strongly in favor of air-cooled condensers.

Low Boiling Organics. Again stainless steel exchangers are required. Installation costs for the air route are higher but the operating costs are slightly lower. If operating cost alone were considered, the economics would favor air. However, when a return on investment is added to reflect the difference in installation costs, the choice swings back to cooling water.

Exhaust Steam. In the case of condensing exhaust steam, the latent heat is quite high requiring a large amount of cooling water. The majority of the capital investment is for providing this water. In addition to higher initial cost, the operating expense for the cooling water route is much higher than for air. The make-up and treatment costs alone are slightly higher than the total operating cost for air. Here, the economics clearly indicate air to be the best route.

Methanol. A comparison for condensing methanol at 15 psig shows installed costs are less for water but operating costs are higher. Using a 10 percent return on investment after taxes, the air route is more economical. When the condensing temperature for methanol, however, is lowered by reducing the pressure to atmospheric, a different picture results. Installation as well as operating costs are higher for air and the economics point to cooling water.

In economic comparisons such as these, an interesting plot can be made of condensing temperature versus a ratio of the total operating cost and return on investment for water to air. The examples given as well as other services are plotted in Figure 1.

Since condensing temperature has a greater effect on economics than most of the other variables considered, a plot of this nature for a given plant can be useful for rough comparisons of new installations. The higher cost of exchanger bundles as compared to total installation cost for air is evident in services where stainless steel is required. In carbon steel or other less expensive alloys, an increase of about 15 F. in condensing temperature is necessary to reach the break even point where stainless steel bundles are used.

The factors discussed are certainly not all that can arise when answering the question, "which cooling medium should be used—water or air?" These, however, are some of the more important considerations and the illustrations make it evident that an automatic selection of cooling water without careful study of all factors involved can be a serious mistake.

Every plant is different and will have points in favor of and against each route. Both routes should be considered for each cooling service. Decisions based on proper evaluation of these factors will reduce production costs and increase plant profits.

Originally presented at the A.I.Ch.E. meeting in Cincinnati, December, 1958. ##

About the Author

Bob G. Perkins is a process engineer for Celanese Corp. of America, Pampa, Texas, where he works on the design of new facilities, improvement of existing facilities, technical service on plant problems and economic evaluations. Previously with Columbian Carbon Co. and Sid Richardson Gasoline Co., he has been with Celanese at Pampa for more than six years in organic chemicals production. Perkins received his B.S. degree in chemical engineering from The University of Texas in 1950.

Air Wins, Even with Water Plentiful

Sohio decided to use air coolers in its new refinery. Here are some of the cost data which show superiority of air coolers

John W. Thomas
The Standard Oil Company (Ohio)
Cleveland

ABOUT TWO YEARS ago, some preliminary studies by Sohio showed air cooling, even in locations where water is plentiful, should be seriously considered as an alternative to water cooling. Subsequent studies for a 60,000 barrel-per-day refinery in the Toledo, Ohio, area and for an expansion in Sohio's Lima, Ohio, refinery showed a considerable savings could be realized by using air cooling extensively. As a result of these studies, 20 percent of the cooling and condensing required in the new facility at Toledo is being done with air. In addition, the principle condenser in a cat cracker revamp at Sohio's Lima refinery is an air cooler.

In this article are shown (1) an economic comparison of air cooling versus water cooling for one large condenser at Sohio's Lima's refinery and (2) an economic comparison of air cooling versus water cooling for Sohio's new 60,000-barrel refinery at Toledo.

Combine Air and Water Cooling. Because air cooling makes it possible only to bring the product being cooled to within 25 F. of the ambient air temperature, it is frequently necessary to use a small water cooler, generally referred to as a trim cooler, along with an air cooler. This means that, with a design ambient temperature of 95 F. a trim cooler is necessary if the hydrocarbon stream must be cooled below 120 F.

Air cooling to this low temperature is not necessarily the most economical approach. In studies at Sohio it was found that the capital cost of an air cooler, plus the cost of a trim cooler, is usually lowest when air is used to cool to 140 F. an a trim cooler is used to cool from 140 F. to the designed outlet temperature. These studies were based on a 95 F. ambient air temperature for air cooler design, and 75 F. wet bulb temperature for the cooling tower design. For 2 percent of the hours, June through September, Ohio has dry and bet bulb temperature equal to or greater than 95 and 75 respectively.

FOR ONE LARGE CONDENSER

At Sohio's Lima, Ohio, refinery a revamp of the cat cracker required the addition of one large condenser. Since the existing cooling tower capacity already was being

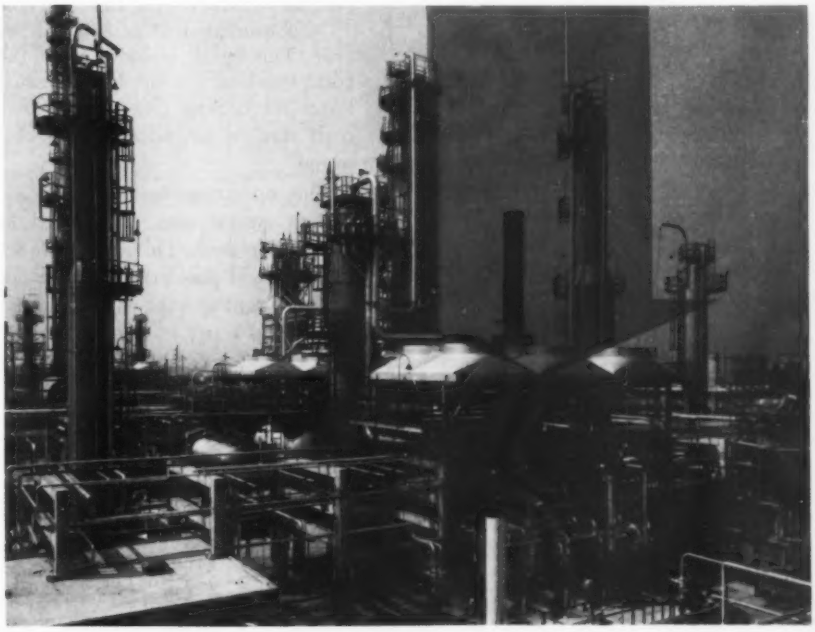

FIGURE 1—Air coolers can be mounted above grade so that space below can be utilized.

taxed to the limit, it was necessary to choose between the installation of an air cooler and a conventional shell and tube cooler. The use of a shell and tube unit would have required the addition of another cell to one of the large cooling towers. Since a study showed air cooling was lower in both capital and operating cost, an air cooler was selected.

TABLE 1—Summary of Costs for a Large Condenser at Sohio's Lima, Ohio, Plant.

Air Cooling[1]		Water Cooling	
Air Cooler	$ 73,000	Water Condenser (3 shells)	$ 45,000
Trim Coolers (water)	6,625	Process Piping	2,876
Process Piping[2]	2,260	Water Piping above grade	2,502
Water Piping (trim cooler) water piping, process piping, foundation & erection	3,435	below grade	8,300
Foundation, fireproofing & erection	7,450	Foundation and erection	3,640
		Cooling tower expansion for 2,200 gpm	
		Tower	35,820
		Piping	7,800
		Pumps & motors	6,180
		Basin, pump & header pit	8,200
Electrical Installation	12,700	Electrical Installation	11,000
Cooling tower charge for 75 gpm	2,600	Make-up water	8,800
Total	$108,070	Total	$140,118
Capital saving using air cooling—$32,048			
Annual operating cost[3]	$ 3,000	Annual operating cost	$16,200
Annual saving in operating and maintenance cost using air cooling—$13,200			

[1] designed to cool from 250–140 F, and running as a flooded condenser operated from Jan. 1 to May 1 at an average of 30 percent of total horsepower.
[2] Process piping for trim cooler included in water piping, process piping, foundation and erection.
[3] Included cooling water charges.

Capital Costs. When comparing capital costs for alternate methods of cooling, one must consider, material plus the installation costs for the different types of coolers, for process piping, for electrical facilities supplying power to air cooler fans, and for the necessary cooling tower, with attendant piping, and water treatment facilities.

In this application the fractionator overhead condenser had the following process specifications:

Duty—33,000,000 Btu/hr.

Temperature (in)—250 F.

Temperature (out)—120 F.

For the air cooler case, a "trim" cooler was selected for cooling the overhead stream from 140 F. to 120 F. Table 1 is a summary of the capital cost comparision between a conventional shell and tube cooling system and an air cooling system to meet the process requirements. The cost of the cooling tower expansion, the shell and tube coolers, and the trim cooler are actual quoted prices.

The total estimated cost for conventional water cooling equipment was $140,000, with the shell and tube equipment itself costing 32 percent of the total figure. The total estimated cost for air cooling was $108,000, with the air cooler cost representing about 67 percent of the total. The dollar savings using air cooling was $32,000 or 23 percent.

Operating Costs. The operating costs for the conventional water cooling system (for the case in Table 1) was estimated to be $16,200 per year. This figure includes all of the costs involved in supplying treated water for cooling plus maintenance costs due to attendent water corrosion.

The operating cost for the air cooling system was estimated at $3,000 per year. This cost includes the electrical power required to operate the fans and the cost of supplying treated water to the trim cooler. It was assumed, in arriving at the operating costs for the air cooler, that power used would be equal to one half the horsepower installed. Since a relatively high ambient temperature (95F.) was used in the design, the actual power used will be considerably below the installed horsepower. (This installation was designed to cool from 250 to 140 F., and operated from January 1 to May 1 at an average of 30 percent of total installed horsepower.)

NEW REFINERY

In 1956, Sohio initiated the design of a new, integrated, 60,000 barrel-per-day-refinery. The refinery was to be located adjacent to Sohio's existing Toledo plant. The existing Toledo plant processed about 20,000 barrels of crude per day, and all cooling was done with "once-thru" lake water. The quantity of water was about 20,000 gpm.

The new integrated plant was designed to run 60,000 barrels per day. In the preliminary studies, it was apparent the existing water line to the lake was not large enough to handle the additional cooling water requirements. This study further showed the addition of a cooling tower was cheaper than the building of a second line to the lake. Cooling tower requirements were set at 30,000 gpm.

The economics of air versus water cooling were considered for each cooler and condenser. As a result of this study, air coolers were selected for eleven units. These are shown in Table 2.

Notice that in Table 2, the inlet and outlet temperatures for each

TABLE 2—Eleven air coolers used in the new 60,000 barrels per day Toledo refinery.

Process Sections	Exchanger	Total Duty BTU/hr	AIR COOLER Temp In F	AIR COOLER Temp Out F	TRIM COOLER Temp In F	TRIM COOLER Temp Out F	Water Saving (gpm)
Crude-Vacuum Unit	Crude Tower Top Reflux Cooler (C105)	16,000,000	233	200	None	None	1467
Crude Vacuum Unit	Heavy Naphtha Cooler (C109)	3,950,000	305	140	140	95	....
Crude-Vacuum Unit	Kerosene Cooler (C110)	7,850,000	375	140	140	95	751
Crude-Vacuum Unit	Light G.O. Product Cooler (C111)	5,050,000	490	140	140	110	....
Crude-Vacuum Unit	Vacuum Twr. Bottom Flux Cooler (C112)	4,100,000	680	450	None	None	234
Cat Cracker	Fractionator O/H Cond (C301)	71,500,000	290	140	140	120	4025
Cat Cracker	Gasoline Splitter O/H Cond (316)	30,740,000	225	130	None	None	1710
Cat Cracker	Decanted Oil Product Cooler (C323)	7,950,000	675	200	None	None	454
Hydrogenation Unit	Lean Oil Cooler (C426)	7,510,000	317	140	140	100	419
Reformer	Reformate Splitter O/H Cond. (C509)	15,410,000	230	150	None	None	838
Reformer	HV Reformate Product Cooler (C512)	14,500,000	320	140	140	120	386

exchanger is shown as well as the reduction in water needed as a result of using the air coolers. While not enough air coolers were used to completely eliminate a new cooling tower, there were enough to substantially reduce the cooling tower size. A real saving in cooling tower and water piping resulted from the reduction in cooling tower size. In cases where the use of air coolers will eliminate the need for adding a cooling tower, a capital cost comparison will be weighted very much in favor of the air cooler.

TABLE 3—Comparison of capital cost and operating cost of air versus water cooling for the eleven exchangers in Table 2.

Water Cooling		Air Cooling	
Capital Cost Comparison			
Shell and tube units	$191,000	Air Coolers	$249,000
Cooling tower and piping	219,000	Trim coolers	63,000
		Structures, platforms, etc	188,000
Total Capital Cost	$410,000	Total Capital Cost	$500,000
Annual Operating Cost Comparison			
Operating Costs	74,500	Operating Cost (Included maintenance)	23,000
Maintenance Cost	14,000		
Total Annual Operating Cost	$88,500	Total Annual Operating Cost	$23,000
Annual Saving in operating cost using air coolers			$ 65,500

Basis for Economic Comparison. Of air cooling versus water cooling was as follows:

- Ambient air temperature used in design of air coolers was 95 F.
- Capital cost for shell and tube units was based on using 13 gage carbon steel tubes (only applied to non-corrosive shell side streams, actually 40 percent of shell and tube area).
- Capital cost of trim coolers was based on admiralty tubes if lake water was the coolant, and carbon steel if cooling tower water was the coolant.
- Gear box drive to be used with air coolers, and cover plate header design was required if fouling or corrosion was expected in the particular service.
- Platforms were required around all air coolers, so as to provide access to both tube ends, motors, and gear boxes. These were considered necessary because air coolers are located high above pipe alleys.
- Ten-gage tubes were used in air coolers wherever corrosion appeared to be likely.
- Maximum size air cooler motor was limited to 20 horsepower.
- Maintenance costs, other than corrosion attendant with water were not included.

Capital Cost Comparison. Table 3 gives a summary of the capital cost comparison between conventional shell and tube units and air cooled units. The total estimated cost for water cooling facilities for the eleven services was $410,000. The cost for air cooling facilities amounted to $500,000.

Operating Cost Comparison. The operating costs for water cooling was estimated at $88,500 per year. This figure includes all cooling plus the cost involved in supplying treated water for maintenance costs due to attendant water corrosion. The maintenance costs resulting from water corrosion are based on an average cost per square foot which has been experienced with brass bundles in our refineries.

The operating costs for the air coolers was calculated at $23,000 per year. This assumes the cost of electric power to operate the fans is based on 50 percent use of the installed horsepower. The operating costs also include required to supply treated water to the trim coolers. Maintenance costs due to water corrosion in the trim coolers is also included. These costs are based on the same average cost per square foot used for calculation of water corrosion cost for the shell and tube case. This is actually very conservative since water side corrosion is a function of temperature level and decreases with lower temperatures. As shown in Table 3, the operating savings realized by using air cooling amounts to $65,500 per year. This is a 74 percent savings. The payout for the additional capital for air cooling is $90,000/$65,500 or 1.4 years.

Other Advantages of Air Cooling. With air cooling, the loss of operating dollars resulting from water fouling is eliminated. This can be a particularly large saving when the units are operating at design and above design capacity.

Fouling attendant with cooling with water requires scheduling for bundle cleaning at least yearly. The cost of cleaning and the cost of associated "unit down time" is appreciable.

In the particular comparison made for Toledo's facilities, water corrosion costs were considered equal to average costs experienced in Sohio's plants with brass bundles.

Since air coolers were used to replace coolers and condensers with carbon steel tubes operating at extremely high temperatures, it's apparent that the maintenance savings used in the economic comparison is quite conservative.

When considering payout and the above advantages of air cooling, Sohio considers their purchase a good invenstment.

Air cooling has a decided place in the process industry. Even in locations where water is plentiful there are many services where air cooling is lower in initial cost then water cooling. In addition, operating costs of air cooling are far lower than operating cost associated with water cooling.

Condensed from a paper orginally presented at an A.I.Ch.E. meeting in Cincinnati, December, 1958.

About the Author

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These Items Help Specify Air Coolers

Air fin coolers will get greater usage in the future, and here are tips to help you specify them

K. D. Segel, Esso Research and Engineering Company
New York City

THE FULL potential of air fin coolers has not been realized. The petroleum refining, chemical and allied industries continually are finding a wider scope of application for this equipment to achieve heat dissipaton. Thus more engineering experience and standardization are needed for air coolers.

A conservative approach naturally is taken because of the newness of applications for this equipment. However, experience is being gained through a review of the past design practices on installed units, through reports of field operations, and from "in-service" performance tests correlated with fin tube design studies. Soon, many of the "engineering judgment" decisions made previously will be supplemented by firm experience-and-data information. Then we can expect to break away from the conservative manner in which air coolers are treated. Furthermore, it is expected future designs will show significantly greater savings in total investment and operating costs.

Standardization of air fin coolers is a goal which would be desirable from both the process and mechanical design viewpoints. The problems posed, however, are more complex than those associated with the standardization of shell and tube equipment. In addition to variables of tube length, diameter, thickness and material in shell and tube equipment there also are questions such as fin shape, spacing, method of fabrication and materials for fin construction. The design ambient temperature and the cost of power within a given refinery have a larger effect on finned tube surface and arrangement than on shell and tube design.

Many problems were presented in the transition period between the time when a design-economic decision was made to use air coolers and their actual installation. Several factors contributed to the problems of evaluating competitive designs: Manufacturers had limited experience for the application of this equipment to the complete range of refinery oil services. Likewise, the users had very limited knowledge of the manufacturers' design and rating methods and little practical field experience and performance data to draw upon for mechanical design requirements. On both sides, there were areas of misunderstanding due to an apparent lack of accuracy and completeness of design information.

With several competitive suppliers and an apparent varience in their rating methods and mechanical design, the procurement engineer is faced with the task of (1) selecting equipment that would most attractively fulfill the process operating conditions, and (2) investigating and determining a standardized approach to the selection of mechanical equipment components for minimizing

spare parts requirements and maximizing interchangeability. Out of this situation evolved the specification form, similar to that shown in Figure 1.

The specification form has proved to be effective in a two-way flow of pertinent information. The supplier is provided adequate process information, and in turn the engineer is provided with sufficient details to properly evaluate the offered selection

Along with the specification form, a comprehensive specification covering acceptable design and construction practices, material requirements, information required with proposals, drawing and inspection requirement also is required to form the basis for competitive bids.

This specification has been applied to a significant number of air fin cooler units with gratifying results. It is, however, continually being reviewed to reflect the best features of existing equipment designs modified to conform with acceptable design and safety practices.

Present practice is to furnish the manufacturer with information relating to tubeside duty, process flow conditions, design air temperature, mechanical equipment and fabrication requirements. The manufacturer establishes the mean temperature difference and transfer rates; and supplies the surface requirements, air load data and the usual cost and delivery information.

Because of the two general approaches to the basic design of air fin equipment, i.e., high surface-low

EQUIPMENT SPECIFICATION FORM

SERVICE _____ EQUIP. SERIAL NO. _____ EQUIP. IDENTIFICATION NO. _____

DRAFT TYPE _____ *MFR. TYPE & DESIGNATION _____ *MFR. JOB NO. _____

DUTY _____ Btu/hr. *TOTAL SURFACE (bare tube) _____ sq. ft. *TOTAL FINNED SURFACE _____ sq. ft.

*LMTD (eff.) _____ *TRANSFER RATE: Service _____ Clean _____ Overall (referred to fin. surface) _____

TUBE SIDE

FLUID _____

FLUID: Fouling _____ Corrosive _____

CORROSIVE COMPOUNDS _____

FOULING FACTOR _____

TOTAL FLUID ENTERING _____ lb/hr.

VAPOR (except steam) _____ lb/hr.

MOLECULAR WEIGHT _____

LIQUID _____ lb/hr.

GRAVITY _____ deg. API @ 60°F.

VISCOSITY (in & out) _____ CP

STEAM _____ lb/hr.

NON-CONDENSABLE GAS _____ lb/hr.

MOLECULAR WEIGHT _____

VAPOR CONDENSED _____ lb/hr.

MOLECULAR WEIGHT _____

GRAVITY _____ deg. API @ 60°F.

STEAM CONDENSED _____ lb/hr.

TEMPERATURE (in & out) _____ °F.

DEG. CONTROL: Product Outlet Temp. _____

PRESSURE DROP (clean) _____ psi

*CALC. PRESSURE DROP _____ psi

NORMAL OPERATING PRESSURE _____ psig

COND. CURVE DATA _____

DESIGN – MATERIALS – CONSTRUCTION

DESIGN PRESSURE & TEMP. _____ psig @ _____ °F.

*NO. PASSES _____ * TUBE PITCH _____

*NO. ROWS (each bundle) _____

*CONNECTED (series/parallel) _____

CORR. ALLOW., HEADER & PARTITIONS _____

MATL: Header _____ Hdr. Cover _____ Plugs _____

MATL: Partitions _____ Tubes _____ Fins _____

NOZZLES: Rating _____ Facing _____ Line Size (in & out) _____

HEADER TYPE _____

*TUBE TYPE _____

TUBE: OD _____ X Min. Wall _____ X Length _____

*FIN: Height _____ *Spacing _____

*SIZE: Bundle _____ *No. Bundles/Section _____

*NO. SECTIONS _____ *TOTAL AREA _____ PLOT AREA _____

*MAX. BUNDLE WT. _____ *TOT. SHIPPING WT. _____

PACKAGING _____ WALKWAYS: No. Sides _____ No. Ladders _____

AIR SIDE

ALTITUDE _____ LOWEST WINTER TEMP. _____ °F.

DESIGN AIR TEMP. IN _____ °F. AIR TEMP. OUT _____ °F.

*TOTAL FLOW _____ SCFM *STAT PRESS _____ in. H_2O

*CORRECTED QUANT. AT FAN _____ CFM

*FACE VELOCITY _____ ft./min. Std Air

MECHANICAL EQUIPMENT

COUPLING: *Mfr. _____ *Type _____

FANS: *Mfr. & Model _____

*Quan. & Diam. _____

*No. Blades/Fan _____ *RPM _____

Blade Material _____

*bhp/fan: design _____ *Winter _____

*Blade Angle Setting (design cond.) _____

HUBS: Type _____

No. (for auto. variable control) _____

*Material _____ *Mfr. _____

Operational Test Req'd _____

LOUVERS: *Type _____ *Mfr. _____

*Material _____

MOTORS: Type enclosure _____

Volts _____ Cycles _____ Phase _____

*Mfr. _____

*Quan. _____ *RPM _____

*hp/each _____ *Total hp _____

TURBINES: *Mfr. _____ *Model _____

*Quan. _____ *RPM _____

*hp/each _____ *Total hp _____

*Steam (in & out) _____ °F. & psi

*Water Rate _____ lb/hp-hr.

GEARS: *Mfr. & Model _____

*Quan. _____ *Ratio _____

*AGMA Rating _____ hp @ RPM _____

DRAWINGS AND INSTRUCTIONS

DESCRIPTION	NO. REQ'D.	DATE REQ'D.
PRELIM. OUTLINE & EL. DWG.		W/proposal
APPROVAL DWGS.		
SPARE PARTS LIST		W/approval dwgs.
FINAL DWGS. & FORMS 1 & 2		
OPERATING INST.		

FIGURE 1—The specification form makes it easier for the supplier and the purchaser to exchange information.

horsepower or low surface-high horsepower, competitive proposals have often disclosed wide differences in the size of units offered for a given duty. Driver horsepower requirements have varied as much as 100% for the same heat load to be removed. Where power costs are high, air fin coolers may prove to be uneconomical. To limit the wide selection of equipment sizes possible through the various combinations of surface and horsepower, the manufacturers are given two additional pieces of information: (1) power investment and operating costs, and (2) available ground area. Bounded by these physical limitations, the manufacturers' equipment design should then represent the optimum selection of surface and horsepower requirements to fit the given conditions.

TABLE 1—Typical Applications of Air Fin Coolers

Service	Duty MM Btu/Hr.	Steam Temp. in, F	Steam Temp. Out, F	Design Air Temp. F	Fan BHP	Nominal Plot Area, Feet
Overhead Condenser	10.0	550	125	100	30	10 x 25 (stacked)
Overhead Condenser	37.0	325	130	95	74	35 x 25
Flue Gas Cooler	18.0	630	130	95	28	10 x 25 (stacked)
Overhead Condenser	70.0	220	150	92	144	50 x 25
Sidestream Cooler	3.5	335	295			
Gas Oil Cooler	4.0	260	125	92	34	15 x 25
Bottom Cooler	0.5	305	175			
Overhead Condenser	55.0	345	120	90	12	62 x 25
Fuel Oil Cooler	31.0	355	135	70	160	65 x 30
Overhead Condenser	15.0	125	95	70	100	30 x 30

Field considerations. In the initial decision to use air fin coolers and the evaluation of competitive makes, several "engineering judgment" decisions were made where specific design knowledge or experience was lacking. During the past two years, the experience gained in design, evaluation, and in field performance has refined many of the fundamental design concepts and requirements of the equipment, and has modified the evaluation techniques for the selection of competitive makes. Highlighting some of these more important considerations:

Maintenance costs for air fin coolers are presently estimated at one-half that for shell and tube equipment. Such maintenance includes replacement of fan bearings, V-belts, external and internal cleaning of finned tubes, and a scheduled routine inspection and maintenance of driver equipment.

Operating costs generally favor air fin coolers over shell and tube exchangers. Estimate studies of total operating costs made for future expansions of process units, have shown possible savings to be as much as 35 percent.

Area requirements for air fin coolers are estimated to be about 15-20 percent greater than area requirements for shell and tube exchangers. Table 1 illustrates area requirements for air fins in typical service applications. Air fin coolers are presently being located within battery limits. They present, however, somewhat of a greater concern from a safety standpoint due to their vulnerability to damage in the event of fire exposure and because tube leakage would be to the atmosphere rather than a closed system. They are not located over pumps, compressors, electrical switchgear, control houses, and in general, the amount of equipment such as drums and shell and tube exchangers located beneath them are minimized. Wherever possible, equipment operating above 600 F are not located beneath air fin coolers. Within battery limits, they are located a minimum of 50 feet horizontally from furnaces, 15 feet from pumps and 8 feet from shell and the tube exchangers, drums and towers.

Air side fouling is essentially negligible according to experience gained thus far. The surfaces can be kept clean by various methods such as hot water spray, steam cleaning, and hand brushing. It has been observed that only the air inlet faces are subject to fouling with middle and top side rows being essentially free of dirt. This of course has minimized the extent of maintenance work and planned time for such maintenance.

Fluid Exit Temperature and Design Air Temperature. The design dry bulb air temperature limits the temperature to which the process fluid can be air cooled. While economics are generally favorable for air cooling to within 40 F. of the design air temperature; in some cases, total air cooling investment costs do not exceed total water cooling investment costs until the process fluid exit temperature is within 20 F. of design air temperature. For a sound economical design it is important that a realistic design air temperature be selected. It is common practice to select a design air temperature as the dry-bulb temperature which is not exceeded 95 percent of the time. To this, however, it is believed practical to add 5 F. for the possible ambient rise due to recirculation of hot effluent air. Temperature records for several years should be used to establish the design air temperature.

For effective year-around performance, it is also important that wintertime temperatures be considered. Fan horsepower requirements must be developed for both design temperature and lowest winter temperature anticipated.

Condensed from a paper originally given at an A.I.Ch.E. meeting in Cincinnati, December, 1958. ##

About the Author

K. D. Segel is an engineer at Esso Research and Engineering Co., Linden, N.J., where he develops and evaluates heat exchanger equipment for refinery process applications. Holder of a B.S. degree in chemical engineering from the University of Pittsburgh, he started his career as a chemical engineer with Westinghouse Corp. He later joined Lago Oil & Transport Co. where he was introduced to heat exchanger problems. At Esso, Segel has been associated with application of air fins to refining.

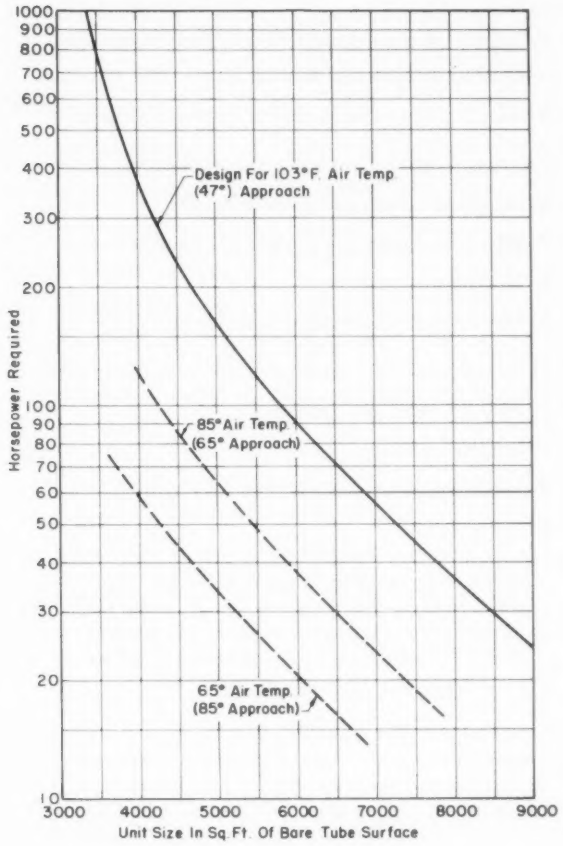

FIGURE 1—(left) The optimum design is found by considering all of the factors which influence the operation of an air fin cooler. This curve shows the relation of horsepower to surface area for cooling 800 gpm water from 250 F to 150 F with parameters of ambient temperature.

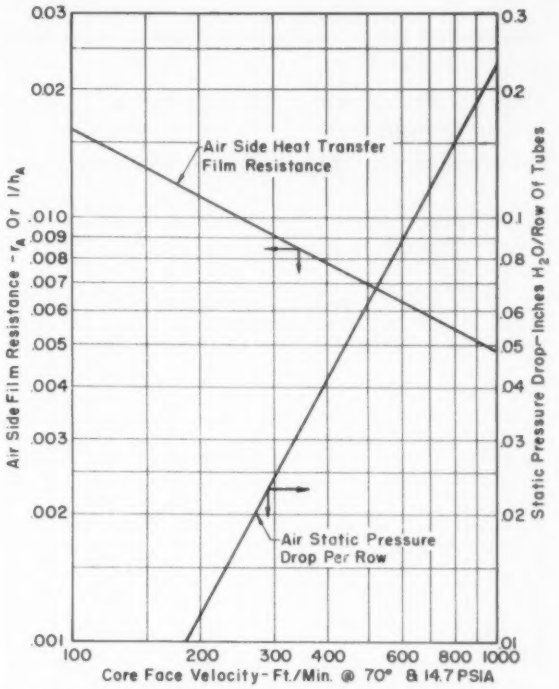

FIGURE 2—(above) The core face velocity is given for a 1-inch OD tube on a 2-1/16-inch square pitch. The tubes have ½-inch fins and 9 fins to the inch. The air film resistance is based on an equivalent bare tube surface.

Find the Best Air Fin Cooler Design

You need to compare investment cost with operating costs in order to come up with the best cooler design. Review the sample problem given here

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EVERY PIECE of process equipment should be evaluated to determine the optimum design. This includes air fin coolers.

A great number of factors affect the determination of the best cooler size. Generally, the intial cost is a function of the bare tube surface and the horsepower requirement. Operating cost is a function of the horsepower.

The optimum size is found by determining first the size for minimum investment. Then it is possible to spend additional money on the equipment to reduce the operating cost. The amount of additional money used to increase the size above a minimum depends upon the other types of capital investment which are available.

Three primary factors affect investment and operating costs. Thus the complicated task of finding the

optimum air fin unit should take each of these points into consideration:

Service which determines the following:

- Type of cooler unit.
- Temperature to which fluid must be cooled.

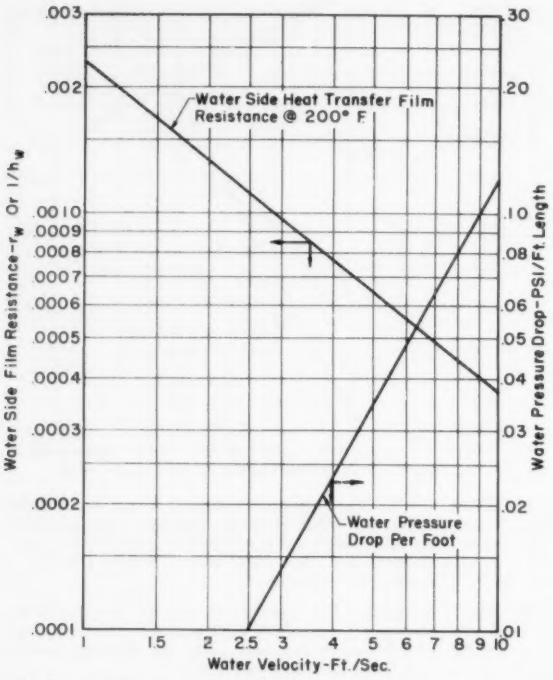

FIGURE 3—The approximate film resistance and pressure drop for the water is for a 1-inch OD tube of 18 gage. The film resistance is based on an equivalent bare tube surface.

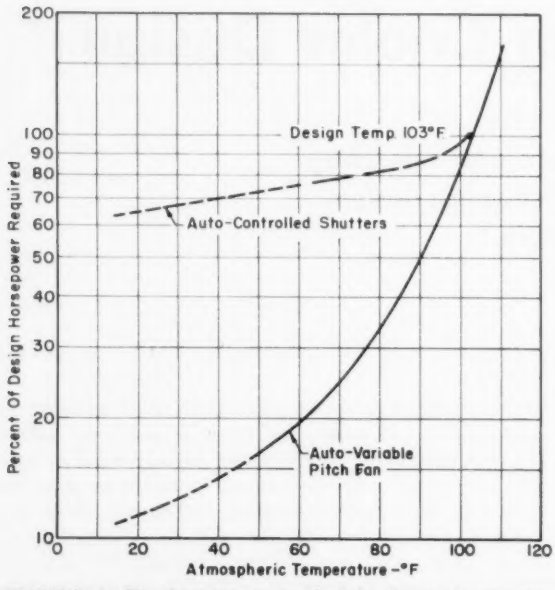

FIGURE 4—The horsepower required for lower air temperatures depends on the type of temperature control employed.

- Degree of temperature control required.
- Overall heat transfer rates.
- In part, life of unit and maintenance costs.

Location which determines the following:

- Design air temperature and density.
- Effect of temperature variation on power costs.
- Electric power rates.
- In part, life of unit and maintenance cost.

Financial conditions which determine the following:

- Price of unit and auxiliaries.
- Installation costs.
- Average annual rate of return.
- Tax rates.

For any given job, generally one or more of the above factors is different; so, for all intents and purposes each air fin unit requires separate analysis whether used in the same service at different locations or different services in the same location.

Types of Air Fin Coolers. The two general classifications of air fin coolers are (1) the forced draft unit where air is pushed across the finned tube surface, and (2) the induced draft unit where air is pulled across the finned tube surface. The forced draft unit gives the primary advantage of requiring less horsepower for the same poundage of air moved. On the other hand the induced draft unit will give better performance for the same poundage of air moved. By nature of the design of the induced draft unit, better air distribution and less air recirculation can be expected.

In a service when sudden temperature change due to rain, sleet, or snow would cause upsets and loss of product, such as a high purity product fractionator overhead vapor condensing service, the induced draft unit would afford the most protection in that only a fraction of the surface would be exposed to rainfall as compared with the forced draft unit.

Use of Air Fin Coolers. Generally, the use of air fins is considered where cooling of a fluid within 35 to 40 F. of the maximum probable surrounding air temperature is desired. In cases where water supply is critical, cooling a fluid to within 20 F. of surrounding air temperature with air fin units may prove practical. Economic evaluation of water cooling versus air cooling would be required in this case. The cooler a fluid is required or the closer to design air temperatures the fluid outlet temperature becomes, the larger the surface and horsepower required (Figure 1).

Use of air fin coolers in series with cooling coils merits consideration where high initial temperatures would cause excessive scaling by use of coils in a cool-

ing tower. Here again, economic evaluation would be required to determine the optimum use of cooling by air and by water.

Listed below are some of the services in which air fin units are used in the natural gasoline industry:

- Engine jacket water cooling
- Lube oil cooling
- Dephlegmator reflux water cooling
- Heavy ends fractionator reflux condensing
- Steam condensing
- Reactor effluent cooling
- Compressor discharge gas cooling

Air Fin Temperature Control Methods. Several methods used in air fin unit fluid outlet temperature control are listed:

- Manually adjusted stepwise air flow by use of multiple fans and two-speed motors.
- Temperature controller operated bypass around unit.
- Temperature controller operated shutters.
- Variable speed hydraulic motor or steam turbine operated by temperature controller.
- Variable pitch fan operated by temperature controller.

As a result of variation in heat load and air temperatures, some type of control for fluid outlet temperature is required in most services. Generally, the air temperature variation is the major factor (Figures 5 and 6). Horsepower requirements to remove a fixed quantity of heat in a given unit vary drastically with changes in temperature from design (Figures 1 and 4). To take maximum advantage of the savings in power costs, use of multifan units and automatically variable pitch fans are justified.

Automatically controlled shutters give good control, but at the expense of power costs. This is also true with bypass controls.

TABLE 1—Design Conditions for Sample Problem

Volume water—800 gpm
Temperature—Inlet 250F
Outlet 150F
Heat Duty—40,000 M Btu/Hr.
Maximum Allowable Pressure Drop—10 psig
Fouling Factor—.001
Location—West Texas at 3,000 ft. elevation
Premise—Use 103 F design air temperature, auto variable pitch fans, and 30% minimum annual average rate of return required.

TABLE 2—Physical Data for Coil Sections (Using 1" OD, 18 Ga., 2-1/16" Sq. Pitch Tubes With ½" High Al. Fins Spaced 9 Fins/In.)

Item	Width Header Coil, Feet	
	5	7.75
No. tubes per row	29	45
Cross-sectional area per row, sq. ft.	0.129	.200
Core face area per ft. of tube length, sq. ft	5.00	7.75
Bare tube surface per ft. of tube length per row of tubes, sq. ft	7.59	11.78
Total extended surface per ft. of tube length per row of tubes, sq. ft.	103.8	161.6

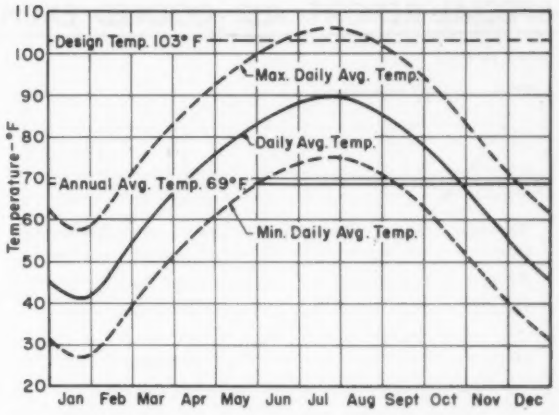

FIGURE 5—The approximate daily temperature variations are for West Texas.

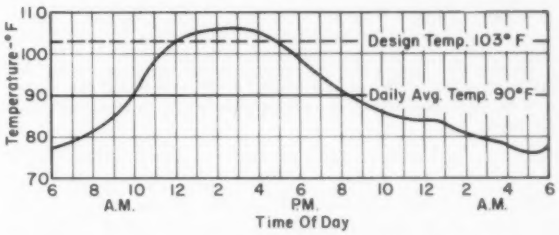

FIGURE 6—The hourly temperature variations in West Texas on July 21, 1954 are shown as an example of how to judge design temperatures.

Use of variable speed steam turbine drives where steam is available or hydraulic motor drives with a master hydraulic pump driven by a gas engine in remote areas merits consideration.

The following problem will illustrate the methods for calculation and evaluation of air fin coolers.

Sample Problem

Basic Data. It is required to determine the optimum size for a dephlegmator reflux water cooler. The design conditions are given in Table 1.

Since air fin units vary with each manufacturer as to coil size, tube pitch, fin heights, fins per inch, etc. it is necessary to obtain sufficient data from them to make a table of physical data as shown in Table 2 and a plot of core face velocity versus air side film resistance (reciprocal of heat transfer coefficient) related to bare tube surface and static pressure drop as shown in Figure 2. Data required to make a plot of water velocity versus water side film resistance related to bare tube surface and water pressure drop as shown in Figure 3 can be obtained from any number of sources such as Kern's heat transfer data.[1] Similar curves could be plotted for any fluid being cooled.

Horsepower vs Size. Using the above tables and curves, calculate the horsepower requirement for several air fin unit sizes as follows:

Step One: Assume a fixed quantity of surface and compute air volume required. For the given sample prob-

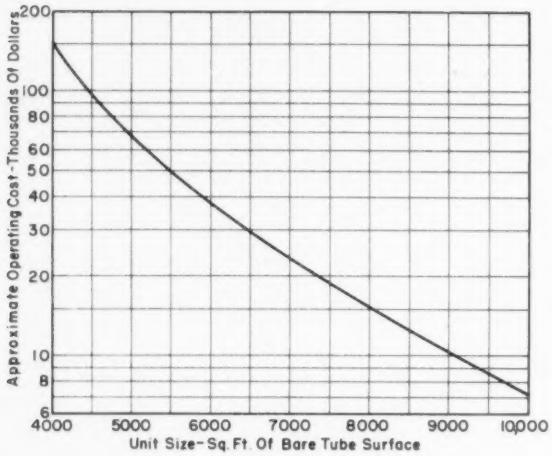

FIGURE 7—These are the approximate operating costs for the exchanger in the sample problem. It is assumed the cooler will be equipped with an auto-variable pitch fan and will last 20 years.

lem use a unit size of 5,654 sq. ft, requiring six 7.75 ft. wide 4 tube row, 20 ft. long, 10 pass coils in parallel.

(a) Compute following physical data from Table 2:

(1) Cross-sectional area for water flow, CSA = $\frac{(0.2\ \text{CSA/tube})\ (4\ \text{rows of tubes})\ (6\ \text{coils})}{10\ \text{passes per coil}} = 0.48$ sq. ft.

(2) Core face area, CFA = (7.75 sq. ft./ft.) (20 ft. length) (6 coils) = 930 sq. ft.

(3) Bare tube surface, BTS = (11.78 sq. ft. per ft. length per row) (20 ft. length) (4 rows) (6 coils) = 5,654 sq. ft.

(b) Check the water side pressure drop for the assumed coil passes and arrangement

(1) Flow volume = 800 gpm @ 60 F. given = 1.84 cu. ft./min. @ 200 F.

(2) Water velocity = $\frac{\text{Flow vol.}}{\text{csa}} = \frac{1.84\ \text{cfm}}{0.48\ \text{csa}} = 3.83$ ft./sec.

(3) Pressure drop thru tubes, P_t = .0215 psi per ft. of travel (Figure 3)
P_t = (.0215 psi) (20 ft. tube length) (10 passes) = 4.3 psia

(4) Pressure drop thru return bends, P_r
Use 4 velocity head loss per pass or

$$P_r = \frac{(4)\ (3.83\ \text{ft./sec.})^2\ (10\ \text{passes})}{(2g)\ (2.4\ \text{conversion factor, ft. head/psi})} = 3.8\ \text{psi}$$

(5) Total pressure drop, $P_T = P_t + P_r = 8.1$ psi
If pressure drop had exceeded the allowable 10 psi, a new assumed coil pass and/or arrangement would be required.

(c) Assume a core face velocity and check surface required against assumed surface of 5,654 sq. ft. by trial and error. For first trial, assume 660 ft./min. CFV.

(1) Air volume = (660 ft./min.) 930 sq. ft. cfa) = 613,800 scfm or 2,768 M lb./hr.

(2) Air temperature rise, Δt =

$$\frac{\text{Heat load}}{(\text{Air, lb./hr.})\ (\text{air sp.ht.})} = \frac{40{,}000\ \text{M Btu/hr.}}{(2{,}768\ \text{M lb./hr.})\ (.24)} = 60\ \text{F}$$

(3) Corrected log mean temperature difference
$T_1 = 250$ F., $T_2 = 150$ F., GTD = 87 F.
$t_1 = 103$ F., $t_2 = 163$ F., LTD = 47 F.
F_T = cross flow temperature diff. correction factor, or .86

$$\text{LMTD} = \left(\frac{\text{GTD} - \text{LTD}}{\log_e [\text{GTD/LTD}]}\right)\left(F_T\right) = \left(\frac{40}{\log_e 1.851}\right)\left(.86\right) = 55.8\ \text{F.}$$

(4) Over-all heat transfer rate, U
U = 1/total heat transfer resistance, R
$R = r_a + r_w + r_m + f$
where r_a = air side film resistance .0060 (Figure 2)
r_w = water side film resistance .0008 (Figure 3)
r_m = tube metal resistance .00007 (18 ga. adm.)
f = fouling factor .001 given
R = .00787, U = 127 Btu/hr., sq. ft., °F.

(5) Surface required, S

$$S = \frac{\text{Heat duty}}{(U)\ (\text{LMTD})} = \frac{40{,}000\ \text{M Btu/hr.}}{(127)\ (55.8\text{F.})} = 5{,}644\ \text{sq. ft.}$$

Since calculated surface required is approximately equal to the assumed surface of 5,654 sq. ft., air volume required is 613,800 cfm @ 70 F. and 14.7 psia. If the required surface had not checked the assumed surface it would be necessary to make additional as-

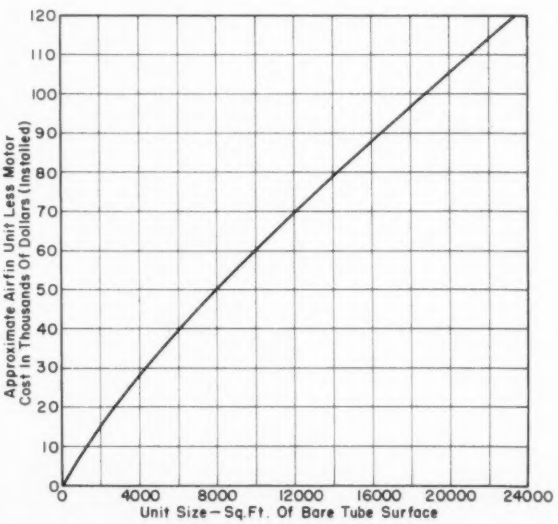

FIGURE 8—The installed costs are needed to determine minimum investment.

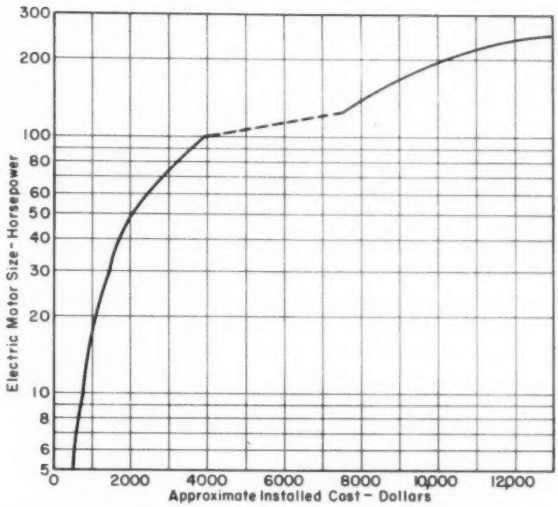

FIGURE 9—These costs are for 1760 rpm electric motors and include the cost of starter, wiring, and installation.

sumptions of core face velocity until the two surfaces matched.

Step Two: Compute the horsepower required for the above assumed unit size of 5,654 sq. ft. needing 613,800 scfm of air. For the coil arrangement use three—14 ft. diameter fans.

(a) Compute air horsepower per fan

(1) Air volume, $Q = \frac{613{,}800 \text{ scfm}}{3 \text{ fans}} = 204{,}600$ scfm

or 239,300 CFM @ fan conditions of 103° @ 3,000′ elev.

(2) Static pressure, P_s = .107″ H_2O/row of tubes (Figure 2)
.107″ H_2O @ Std. cond. = .132″ H_2O @ coil conditions of 200 F. @ 3,000′ elevation.
P_s = (.123″ H_2O) (4 rows of tubes) = .528″ H_2O

(3) Velocity pressure, P_v =

$$\frac{(\text{Vel.}^2)\ (\text{air density @ fan cond.})}{(2g)\ (5.2 \text{ conversion factor})}$$

$$\text{Velocity} = \frac{239{,}300 \text{ cfm}}{(151 \text{ sq. ft. fan csa})\ (60 \text{ sec./min.})} = 26.4 \text{ ft./sec.}$$

$$P_v = \frac{(26.4)^2\ (.0643)}{(64.4)\ (5.2)} = .134″ \text{ } H_2O$$

(4) Air HP $= \frac{(Q)\ (Ps + P_v)}{6{,}346} =$

$$\frac{(239{,}300)\ (.662)}{6{,}346} = 25.0 \text{ HP}$$

(b) Compute total brake horsepower required

(1) Efficiencies
Fan efficiency = 72% obtainable from fan manufacturer's curves
Gear or V-Belt drive efficiency = 95% assumed.

(2) BHP required/fan $= \frac{\text{Air hp}}{\text{Fan \& Gear Eff.}} =$

$$\frac{25.0}{(.72)\ (.95)} = 36.6 \text{ hp}$$

(3) Total BHP required = (36.6 hp) (3 fans) = 109.8 hp
For the assumed unit of 5,654 sq. ft. 109.8 bhp, or use of three 40 hp electric motors would be required.

Operating Cost. Determine the operating cost by using the following equation:

Total Operating Cost = $(a)\ (b)\ (c)\ (d) + e$

Where:

a = Horsepower required at design air temperature. It is computed by the method previously described and plotted as in Figure 1 for various unit sizes. This curve would be different for each different type of fluid being cooled.

b = Horsepower correction factor. To get it first compute the effect of air temperature on horsepower required for a given size unit in terms of percent of design horsepower required, as shown in Figure 4. The values obtained are dependent upon the method of control. For example, if a multiple fan unit with an automatic shutter placed above one fan were used, horsepower values would be reduced compared with having shutters over the total unit.

Next, the percentage of time during the years in increments between maximum and minimum

TABLE 3—Justification for Expenditure Above Minimum Investment (Using 30% Annual Average Rate of Return Required)

Trial	Base	1	2
Expenditure Over Min. Inv., $	0	1,500	2,000
Total Investment, $	40,500	42,000	42,500
Unit Size, Sq. Ft	5,000	5,700	5,800
Depreciation, $/Yr. $\left(\frac{90\% \text{ x inv.}}{20 \text{ Yrs.}}\right)$	1,822.50	1,890.00	1,912.50
Operating Cost, $/Yr.	3,350	2,200	2,090

Comparison of:	Trial 1 to Base	Trial 2 to Base
Diff. in Inv., $	1,500.00	2,000.00
Diff. in Depreciation, $/Yr. (Credit)	67.50	90.0
Diff. in Oper. Cost, $/Yr. (Credit)	1,150.00	1,260.00
Taxable Income, $/Yr. (Diff. in Oper. Cost Minus Diff. in Depr.)	1,082.50	1,170.00
Taxes Payable, $/Yr. (Taxable Income x Tax Rate)	562.90	608.40
Net Savings, $/Yr. (Diff. in Oper. Cost Minus Taxes)	587.10	651.60
20 Yr. Discount Factor (Diff. in Inv./Saving After Tax)	2.555	3.069
Avg. Annual Rate of Return (From Discount Tables)	39% (High)	32.3% (o.k.)

Use of 5,800 sq. ft. unit requiring 100 horsepower is justified. Had required annual average rate of return been 14%, a 7,000 sq. ft. unit with less horsepower would have been justifiable.

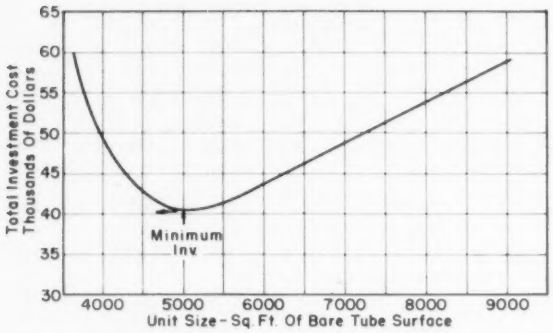

FIGURE 10—A plot of total investment shows what size cooler gives lowest investment.

temperatures is determined by use of temperature plots for the location, as shown in Figures 5 and 6. For example, in West Texas the percentage of time per year that temperatures are equal to or above 103° is 1.45% between 71° and 76° is 11.84% and equal to or below 31°F. is 2.44%. Temperature data for a given location can be obtained from area records or the U.S. Weather Bureau.

By taking the summation of the percent of time per year at incremental temperatures multiplied by the corresponding percent of design horsepower required will give the horsepower correction factor. For the above sample problem, the correction factor is 28.5%. It will be noted that the factor would be quite different were this unit located in a place where annual and daily temperature variations are less.

c = Annual purchased power cost. Use an average KW rate for the particular location in terms of dollars per horsepower per year, taking into account electric motor efficiencies. For the sample problem, the annual cost per horsepower of $73 is used.

d = Expected life of a unit. It is an arbitrary figure and depends upon service and location to a great extent. For the above problem, 20 years is assumed.

e = Maintenance. It is an estimated cost to keep the unit in operating condition. For the sample problem it is assumed to be negligible.

Using the above equation, the operating cost for various unit sizes is calculated and plotted in Figure 7.

Minimum Investment. Determine the minimum investment cost by plotting the total investment cost for the various units sizes. Total investment cost is the sum of estimated installed cost of air fin unit without motors plus the estimated installed cost of the electric motors including starters and wiring. An estimate of installed costs of air fin units without motors for various air fin unit sizes is shown in Figure 8. An estimate of installed costs of electric motors for various electric motor sizes is shown in Figure 9. It will be noted that total investment cost would depend, in part, on the number of motors installed in a given unit. For example, if 30 hp were required, one 30-hp motor would cost less than three 10-hp motors.

As shown in Figure 10, there will be a point where total investment reaches a minimum, which happens to be $40,500 for the sample problem.

Justification. Determine the amount of additional money that can justifiably be spent for a larger than minimum investment unit based on savings in operating cost by a method such as outlined in Table 3. For the sample problem an additional expenditure of approximately $2,000, or a unit size of 5,800 sq. ft., is justified. The 5,800 sq. ft. unit represents the optimum design size. Had 14% instead of the 30% annual average rate of return been used, a 7,000 sq. ft. unit would have been optimum.

The calculation in Table 3 shows that money above minimum investment not spent for an air fin cooler could be invested elsewhere at a given rate of return for an equivalent number of years; therefore, a check is required to see how much additional money spent for a unit would give an equivalent rate of return using increased depreciation and decreased operating costs as credits.

Several factors assumed in Table 3 that would alter the picture if changed are (1) 20-year life of unit, (2) straight line depreciation, (3) constant yearly operating costs, (4) 52% tax rate, and (5) 30% minimum average annual rate of return on money invested required.

The 30% rate of return figures is strictly for illustration. Since rate of return required on investment is a judgment figure on the part of management based on several factors such as company financial position, current economic conditions, hazards involved, etc. the engineer must keep in close contact with top management's current thinking for arriving at a figure to be used.

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ACKNOWLEDGMENT

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[1] Kern, Donald Q., "Process Heat Transfer," McGraw-Hill Book Company, Inc., New York (1950).

About the Author

E. U. Nakayama is a process engineer for Phillips Petroleum Co., Bartlesville, Okla., where he works in the process design and development of natural-gasoline-plant facilities. Holder of a B.S. degree in mechanical engineering from the University of Oklahoma, he has five years experience in West Texas in gasoline-plant maintenance, operation, and efficiency checks. Nakayama has been at Bartlesville seven years, developing gas compressor stations, distillation units, and upgrading facilities.

Field Tests Needed for Air Coolers

An appeal for standardized performance tests, this article makes recommendations regarding: test technique, procedure and equipment

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IN FIELD performance testing of air-cooled heat transfer equipment, there appears to be a decided lack of uniformity in test procedure and, consequently, in the test results. Field testing of air-cooled heat transfer equipment is difficult even under good conditions, and good conditions rarely exist. Ambient air is never cooperative. The wind varies in intensity and direction. For part of the test the sun is behind a cloud, for the rest of the test it is scorching the earth. Tube side flow rates and temperatures often vary from minute to minute. Seldom are meters installed so that it is possible to measure the tube side flow rate. Frequently there isn't a sufficient length of straight pipe in which to install a pitot tube or other measuring device.

Heat balances of ± 10 to 25 percent on this type of equipment have been common and even expected in a field test. It is believed, however, that by using the test procedure and equipment described in this paper the over-all transfer can be determined within less than ±5% accuracy and that a heat balance within less than ±10% can be obtained provided the tube side temperatures and flow rates can be measured with suitable accuracy.

The author has witnessed several performance tests in which the procedure was extremely poor. The over-all transfer rate calculated from the data of these tests deviated from the average by over 18%. A representative of the manufacturer participated in some of these tests. His comments on the widely varying transfer rate was that such was to be expected on a field test. These examples clearly illustrate the need for a standard test procedure sanctioned by some interested organization.

Some Recommendations. A standard test procedure should be based on air side data with tube side data used for "check" purposes only. As the results of the test cited in this paper will show, air side data can be obtained with good accuracy. Moreover, portable instruments suitable for doing a good job of measuring air side data are cheap by comparison to the cost of installing tube side flow measuring equipment on each air-cooled unit. Furthermore, the specific heat and physical properties of air are well known. This is not always true of the tube side fluid. So if a simple, reliable, and accurate method of measuring heat dissipated to the air is available, it is pointless to be concerned about tube side fluid composition, enthalpies and flow rates.

A standard test procedure should designate the over-all transfer rate as the criterion for judging acceptability of an exchanger. It is true that the approach temperatures is the thing that users want to obtain but it is not a suitable measure of the acceptable performance of heat exchanger. Approach temperatures are affected by many factors. Actual heat loads, flow rates, compositions and temperatures usually are considerably different from design. These variables are difficult to predict because many of them are associated with the development of an oil field or the allowable production rate set by regulatory bodies of the state.

In evaluating the performance of an air-cooled exchanger in which there is little or no phase change, it is our practice to calculate the design inside or outside transfer rates, whichever appears easiest. Then using the design over-all transfer rate, the other value is obtained. The design inside transfer rate is then multiplied by the ratio of the actual tube side flow rate existing during the test to the design flow rate raised to the 0.8 power. This manipulation yields the inside transfer rate for test conditions which is recombined with the design outside transfer rate to give the design over-all transfer rate corrected for actual flow conditions. The over-all transfer rate determined by the test is expected to exceed this corrected over-all rate.

In extrapolating the over-all transfer rate in this manner it is tantamount to saying that it is no concern of the user's whether the fan actually pumps more or less air than design so long as the unit will meet the corrected design over-all transfer rate. This is our position. It is only when the unit does not meet the design over-all rate that fan performance is important to the user. In such cases, the manufacturer is as much responsible for providing adequately sized fans and drivers as he is to furnish sufficient surface.

The question always arises as to whether a new unit should be expected to meet the design "clean" over-all rate or the design "foul" over-all rate. If there is reason to suspect that the unit is fouled, it is cleaned immediately prior to the performance test and the over-all transfer rate is expected to be somewhat higher than the design fouled rate. There is no set policy as to

how much higher it should be. This is a matter which a standard test procedure should attempt to define. It would be well to mention some of the more common reasons users have for testing air-cooled exchangers.

Why Tests Are Needed. In new plants all types of equipment are tested soon after being put into operation. This is done as a standard part of the construction section's job. Several cases of severely malfunctioning equipment have been found. Some of the cases have been due to construction debris, others to misapplication of the equipment or manufacturing errors. In some cases it has been a simple matter of overrating the equipment. These initial tests later serve as a useful reference point for diagnosing problems of operation and maintenance.

Another reason for testing the equipment is that most manufacturers guarantee their workmanship and materials for a period of one year. The plants are designed for ultimate loads which rarely exist during the guaranty period. Therefore, the equipment is tested within the guaranty period and the results are extrapolated to design conditions, as previously described. The manufacturer is notified if the test indicates the equipment will not meet the specifications on which it was purchased. Usually the manufacturer sends a representative to witness a retest of the unit. At this point the need for a standard test procedure certainly becomes apparent. The manufacturer profits from these tests, too, in the long run.

Recently, a user tested an air-cooled engine jacket water cooler consisting of two large units and found that it would handle only 42.6% of the design heat load. The manufacturer made some modifications to the unit and it then handled 64% of the design heat load. Further modifications were to no avail and the manufacturer furnished, without charge, a complete new unit. Later, it was found that the extruded aluminum fin tubes did not contact the tube liners throughout the length of the tubes. The manufacturer now uses a quality control test to prevent a recurrence of such a costly accident.

Tests are also run to determine the need for additional equipment or determine when and what maintenance is required.

TABLE 1—Summary of Test Data

MEASUREMENT	JACKET WATER TEMPERATURES, °F		
	Outlet		Inlet
Position	(1)	(2)	(3)
Run			
1	156.1	155.8	164.5
2	153.9	154.9	162.8
3	156.7	156.7	167.7
4	154.3	154.9	163.9

MEASUREMENT	AMBIENT AIR TEMPERATURE, °F					
Position	(4)	(5)	(6)	(7)	(8)	(9)
Run						
1	98.9	97.3	94.6	96.7	100.3	101.1
2	95.0	94.0	93.4	95.0	94.4	96.9
3	92.1	92.9	88.4	89.9	92.4	95.7
4	91.9	89.1	88.1	87.9	90.2	91.6

	AIR OUTLET							
Measurement	Vel. Ft/Min	Temp. °F	Vel. Ft/Min	Temp. °F	Vel. Ft/Min	Temp. °F	Vel. Ft/Min	Temp. °F
Position	(10)		(11)		(12)		(13)	
Run								
1	560	145.8	444	143.4	475	144.7	497	146.6
2	507	144.9	442	142.5	503	141.9	462	144.0
3	501	143.5	529	145.9	497	140.5	578	143.0
4	575	142.2	515	142.3	630	141.8	456	142.8
Position	(14)		(15)		(16)		(17)	
Run								
1	795	143.8	444	142.7	595	147.5	620	144.1
2	560	143.7	572	143.7	591	145.1	610	140.7
3	566	145.5	550	144.1	653	143.1	610	138.5
4	651	142.5	622	142.9	678	143.5	562	140.6
Position	(18)		(19)		(20)		(21)	
Run								
1	570	148.2	591	145.9	560	147.3	523	144.2
2	542	147.2	639	138.5	639	141.9	562	144.1
3	571	148.3	578	146.5	568	145.4	464	144.3
4	552	144.5	570	143.4	645	140.2	562	143.9
Position	(22)		(23)		(24)		(25)	
Run								
1	620	147.9	537	147.9	616	145.1	485	147.7
2	605	148.1	572	143.4	483	142.0	487	146.5
3	599	148.1	450	149.5	513	147.0	591	145.5
4	501	149.1	479	139.8	487	143.4	436	149.5

Run	Air Velocity ft/mm Avg.	Bundle	Pilot Tube Readings, √In. H_2O on 20" Chart 1	2	3	4	△P., In. Hg.
1	558	East	6.83	7.08	6.94	7.10	2.7
		West	7.18	7.23	6.98	6.70	
2	555	East	6.78	6.94	6.91	7.12	2.7
		West	7.07	7.34	7.09	6.89	
3	551	East	6.64	6.98	6.86	7.10	2.6
		West	6.93	7.8	6.96	6.72	
4	558	East	6.71	7.00	6.82	7.07	2.7
		West	7.13	7.20	6.90	6.62	

Here's an Example Test. The performance test, which is reported herein, illustrates an unusual reason for testing air-cooled exchangers. On the exchanger tested, radiator type cores or bundles had been replaced with round, finned tube type bundles using the existing structures, plenum chamber, fan, fan ring, and fan drive. At the time of the test, replacement had been made on the number 1 jacket water cooler only. Five more coolers were to be replaced. While the manufacturer's design of the new bundles had been carefully checked, it was felt that a performance test was justified to make sure that this was a happy "marriage" of two strangers before spending an additional $40,000. The plant was operating above design load and the company could ill afford to have the compressor station operating at part load while engineers searched for an error in calculations.

The test procedure and equipment to be described were used to test a hybrid exchanger, as previously indicated. In making the change from radiator type cores to round finned tubes, two new tube bundles in parallel were used. Each new bundle was single pass and consisted of 215 5/8-inch O.D., 20 B.W.G., phosphorus inhibited admiralty tubes. The tubes are 17 feet, 9 inches long with 9 half-inch-high extruded aluminum fins per inch. Tube spacing is 1 9/16-inch square pitch, four rows deep with the top row staggered. Each bundle is 7 feet, 2 inches wide with a box type header at each end. The unit is an induced draft type, utilizing a 12-foot diameter, steel-bladed fan, driven by a 5-15 horsepower, two-speed, electric motor through a right angle reduction gear. At the time this unit was tested, it had been in service about six months.

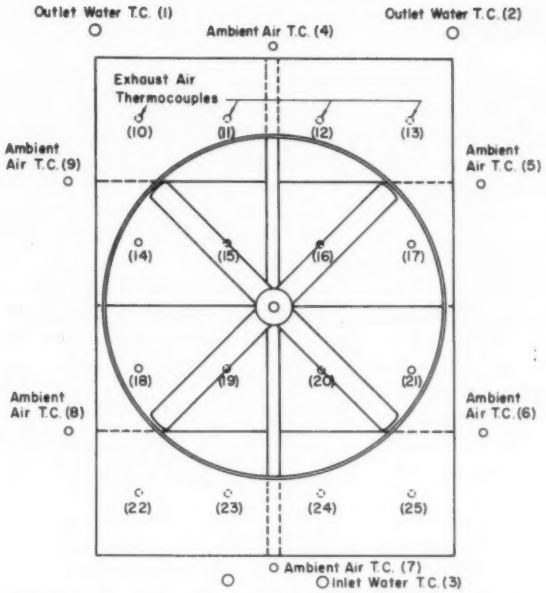

FIGURE 1—All temperatures were measured with thermocouples. This diagram shows where each one was located.

TABLE 2—Summary of Calculated Results

Run No.		1	2	3	4
Air Side					
Avg. Temp. In	°F	98.2	94.8	91.9	89.6
Avg. Temp. Out	°F	145.8	143.6	144.9	143.3
△ T Air	°F	47.6	48.8	53.0	53.7
Avg. Air Velocity @ Amb. Cond.	Ft/Min.	558	555	551	558
Air Flow Rate (14.65 psia & 60°F)	SCFM	106,600	106,700	106,500	108,300
Air Side Heat Load,	MM Btu/Hr.	5.59	5.74	6.22	6.41
Water Side					
Temp. In	°F	164.5	162.8	167.7	163.9
Avg. Temp. Out	°F	155.9	154.4	156.7	154.6
△ T Water	°F	8.6	8.4	11.0	9.3
Water Rate (Pitot)	Lb/Hr.	640,900	642,000	633,200	634,200
Water Rate (Press. Drop)	Lb/Hr.	640,800	646,200	636,000	640,800
% Difference	%	.015	.65	.44	1.035
Water Side Heat Load (Pitot)	MM Btu/Hr.	5.51	5.39	6.96	5.90
Heat Balance (Pitot Water Rate Heat Load Difference as % of Air Side)	%	1.45	6.52	10.6	8.64
LMTD (Corr. Fact.) Both Fluids Un-mixed		.98	.97	.96	.98
LMTD (Corrected)	°F	33.9	34.5	39.0	37.9
Overall Transfer Rate					
Based on Air Side Heat Load	Btu/Hr-Ft² °F	134	135	129.6	137.5
Average			134		
% Deviation From Avg.		0	+ .74	−3.2	+2.6
Based on Water Side Heat Load	Btu/Hr-Ft² °F	132	127	142	127
Average			132		
% Deviation From Avg		0	−3.8	+7.6	−3.8

In general, the test procedure consisted of getting the water rate constant by "locking in" the automatic control valve and maintaining the engine load constant. Then temperatures were taken, air and water velocities were measured, and temperatures taken again. Temperatures shown in Table 1 are the average of the two readings. Each datum was measured as follows:

All temperatures were measured with Iron-Constantan thermocouples using manual balance portable potentiometer. This is an extremely sensitive instrument with calibrated accuracy of ± 0.01 M.V. (or approximately 0.3 F. with Iron-Constantan thermocouples.) It was necessary to mount it on rubber mats to avoid deflection of the galvanometer pointer due to vibrations from the ground. Reference junction was in an ice bath. Prior to the test, thermocouples were calibrated at approximately 100 F. and 210 F.

Water temperatures in and out were obtained from thermocouples in stainless steel thermometer wells located in the piping. The wells were filled with oil. Thermocouples for measuring ambient air temperatures were suspended approximately 18 inches below the tube bundle on the outside periphery of the unit. This location was chosen so that the temperature of re-circulation air, as well as of ambient air, would be measured. A plan view of thermocouple locations is shown in Figure 1.

To get exhaust air temperatures, the unit was shut down during the cool morning hours and thermocouples were placed in sixteen equal areas of the top surface of the tube bundles. The thermocouples were held in place and supported about 8 inches above the tube bundle with bailing wire.

Air flow rate was obtained by measuring air velocity with a 4-inch diameter, revolving vane annemometer. The annemometer had been calibrated at an industrial testing laboratory a short time before the test. Face area of the tube bundles was divided into 16 equal areas, each approximately 3½ feet x 4½ feet. Readings of 30-second duration were taken in each area. In taking the readings, the annemometer was held approximately 2 inches from the face of the tube bundle and moved slowly and uniformly over the area. Annemometer calibration factors were applied to each reading taken. An average of the sixteen velocity readings was multiplied by the net free face area to obtain the air flow rate. Net free face area was determined by multiplying the distance between inside edge of channel beams on each side of the bundles by the distance between tube sheets and subtracting area of cross members and tube supports.

Water flow rate was measured in two ways. One way was by pressure drop through the cooler, using a mercury manometer. Pressure taps were in the plug sheets on each header box at the opposite ends of same tube. In the calculations for flow rate, using this method of measurement, corrections were made for tube entrance and exit losses. The second method of obtaining water rate was to measure the water velocity by a single plane pitot tube traverse in each of the 6-inch inlet water lines. Impact and static pressure differences were measured with a 20-inch bellow-type recording flow meter.

Table 1 is a summary of test data arranged in approximately the relative location at which it was taken.

In studying the data, several points become of interest. The first point is that the air velocity through any given area varies radically from one run to the next. However, the average of sixteen velocity readings in each run is very nearly a constant—about 1.5 percent variation. Another point that is interesting is the ambient air temperature on the side of the test unit next to the number 2 unit is consistently higher than those on the open side of the unit. If this were an acceptance test, this point would be significant to the manufacturer. He has no control over spacing of the units and would not want his unit charged with ambient air temperature 3 or 4 degrees colder than was actually going to the unit. This also indicates that 10-foot spacing between the units is not adequate to avoid recirculation. Naturally, this would be of greater significance if the application called for a 20 or 25 F. approach to ambient air temperature. It should also be noted that the exhaust air temperatures varied as radically as the air velocities.

The calculated results of the four test runs are shown in Table 2. As mentioned previously, the air velocities are nearly constant so the air flow rate is practically a constant. This is as expected. It is somewhat surprising, though, to find the water flow rate determined by the pitot tube corresponds so closely to that determined by measuring tube side pressure drop. In calculating water rate from the pressure drop measurement, the friction factor curve shown in D. Q. Kern's book *Process Heat Transfer*[1] was used in conjunction with the tube entrance and exit loss curve shown in Scovill's *Heat Exchanger Tube Manual*.[2] Close agreement between the two water rate measurements was unexpected because it was thought that the pressure drop determination would be only a crude check that might help verify the heat load calculated from air side data. Before the test was made, it was generally conceded that the pitot tube location was poor. It was approximately 18 inches downstream of a 45-degree weld ell which was immediately preceded by an open gate valve. Moreover, only a single plane traverse was to be made and, furthermore, the pitot tube was not long enough to reach the last two points of a six-point traverse. Nevertheless, good agreement between the two methods of water rate measurement was obtained.

Equal good fortune did not exist for the heat balances. In the four runs, heat balances varied from about 1.5 percent to 10.6 percent of the air side heat load. It is the author's opinion the lack of agreement in the heat balance is due to the use of lube oil in the outlet water temperature thermometer wells for a conductor. Again, it is pointed out that air rates were constant, water rates measured by two different methods were in good agreement, inlet water temperatures during any one run were nearly constant, and air temperatures were measured by direct stream immersion. Ambient air temperatures varied some from start to finish of a run. Therefore, it is believed that due to relatively poor conductivity of the lube oil, the thermocouple immersed in it did not follow the outlet water temperature closely. Since the water temperature change is only 8 to 10 F., a small error materially affects the heat balance. Actually, heat balances only served as an indicator of the accuracy of the test data. Where there is appreciable disagreement in the heat balance, a choice must be made as to which is more reliable, the air side data or the tube side data.

In the four runs reported in Table 2, the average over-all transfer rate calculated from the air side heat load is 134 $\frac{\text{Btu}}{(\text{Hr})\ (\text{Ft}^2)\ (^\circ\text{F})}$. The maximum deviation from the average was a —3.2 percent. The average over-all transfer rate calculated from water side data is 132 $\frac{\text{Btu}}{(\text{Hr})\ (\text{Ft}^2)\ (^\circ\text{F})}$. The maximum deviation from the average was +7.6 percent. If the average over-all transfer rate determined from air side heat load were corrected for the variation in the air and water flow rates, from run to run, the maximum deviation from the average would be slightly less than 3.2 percent. The fact that this deviation is so small substantiates one of the main points of this paper, that is, in general a more reliable performance test can be made using air side data than using tube side data.

Having field tested a number of air-cooled exchangers, using different tools and techniques, and sometimes with indifferent results, the author feels that the procedure and equipment described herein will give uniform and reliable results. Certainly, the method can be improved upon.

One improvement would be made by using a "grid" of thermocouple points on the inlet air side of the bundles the same as was done for the exhaust air temperatures. Another improvement would be direct stream immersion of the thermocouples where feasible. Where unfeasible, powdered aluminum or some other good conductor in the thermometer wells would be preferable to oil.

Original presentation was before an A.I.Ch.E. meeting in Cincinnati, Ohio, December, 1958.

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[1] Kern, Donald Q., "Process Heat Transfer," p. 836, McGraw-Hill Book Company, Inc., New York (1950).

[2] Scovill Manufacturing Company, "Heat Exchanger Tube Manual" 3 ed., p. 47, Waterbury 20, Conn. (1957).

About the Author

Jerry F. Todd is a mechanical maintenance engineer for Magnolia Petroleum Co., Dallas. At present he is working on the solution of mechanical maintenance problems in the company's natural gasoline plants. Todd received his B.S. degree in mechanical engineering from Stanford University in 1949 and joined Magnolia in 1950. He has served as plant engineer, construction engineer and project mechanical-construction and design engineer.

How to Estimate Cooling Tower Costs

Here are factors which must be considered when designing, selecting and estimating induced draft cooling towers

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COOLING TOWERS are the largest type of industrial heat transfer equipment in use today and constitute one of the most difficult items of plant equipment to specify and evaluate. The purpose of this article is to describe the basic types of induced draft cooling towers, factors to be considered in preparation of design specifications, economic considerations in selecting the tower, and to present a method for accurately estimating the cost of cooling tower installations. Data is given on cooling tower prices and installation costs in relation to capacity and design operating conditions for towers of capacities up to 75,000 gallons per minute of water.

DESIGN CONSIDERATIONS

The engineer responsible for establishing design specifications must have a detailed knowledge of the basic principles involved in cooling tower design and performance in order to establish logical and realistic specifications. The factors which influence the size and therefore the cost of a cooling tower are *the design wet bulb temperature, the approach, the cooling range,* and *the quantity of water to be cooled.*

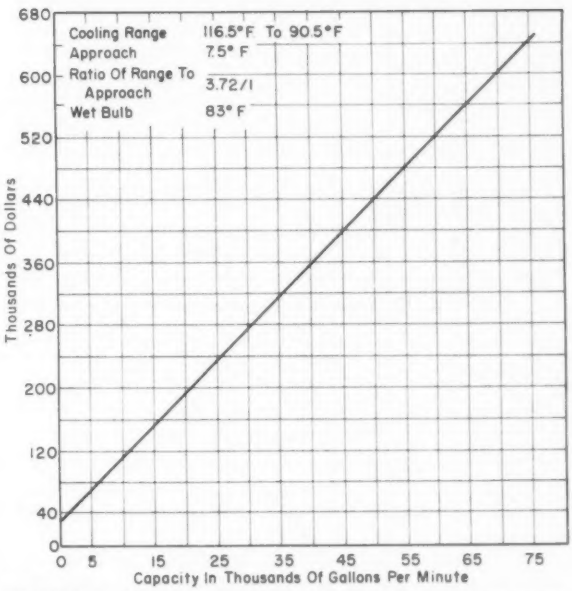

FIGURE 1—Shows the direct cost of induced draft cooling towers. Included is—cooling tower and erection, fans and motors plus installation, concrete basin with pump pit, but excluding pumps and piping.

In determining the wet bulb temperature, a value should be established that will prevail at least 2 to 5 percent of the operating hours each year or one that is about 5 F. below the maximum expected. Acceptable values are available in most engineering handbooks and reliable data can be obtained from the Weather Bureau. In some cases, a correction of up to 2 F. must be made to correct for recycled air which actually increases the wet bulb temperature of the incoming air. In addition, further corrections are necessary if the cooling tower is located in a confined

THERE ARE THREE BASIC TYPES

In the induced draft cooling tower, the fans are located in the exit humid air stream at the top of the tower. The air enters the tower sides at a low velocity and is drawn to the top of the tower by the fans. All induced cooling towers can be grouped into three distinct classes. The differences are in the way air enters the tower and the way in which it contacts the water.

The three types are counterflow, crossflow and a combination of these two called a back-to-back counterflow type. The counterflow is the more conventional type and provides vertical air movement across the filling before discharging through a drift eliminator to remove entrained water.

The crossflow cooling tower is equipped with one or more fans at the top which draw air through two cells paired to a common suction chamber partitioned midway beneath the fan and fitted with drift eliminators that direct the air upward toward the fan outlet. This arrangement provides horizontal air flow with the water falling across the air stream.

The back-to-back counterflow tower also employs counterflow cooling which is provided by placing the cells back-to-back and using an air tunnel arrangement in the bottom of the tower to distribute the air to the interior of the tower.

The type of cooling tower fitted to any application must be analyzed for each case individually and a study of this type is beyond the scope of this article.

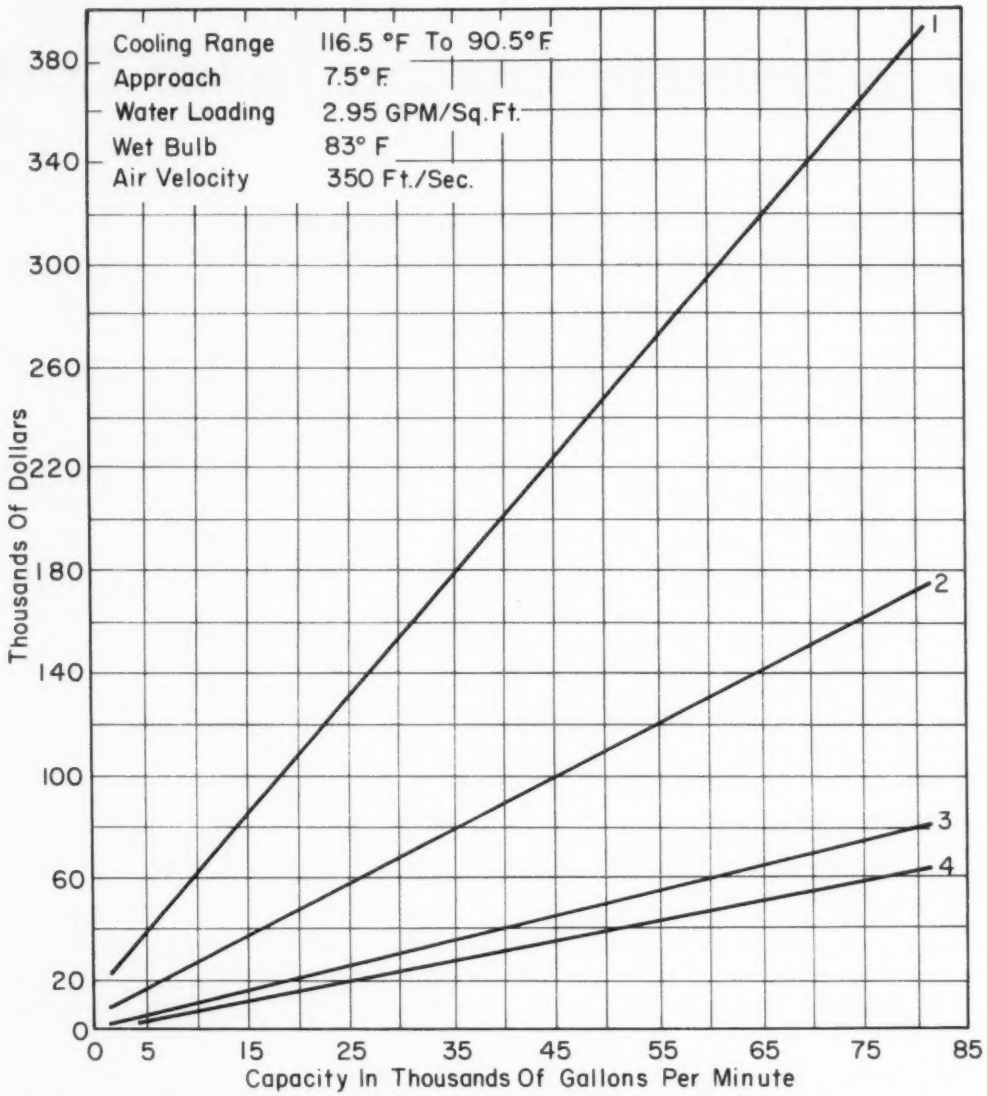

FIGURE 2—Here is a breakdown of various items of direct cost. Curve 1—cooling tower cost (includes fans without motors, freight and supervision). Curve 2—concrete basin and pump pit—labor and material. Curve 3—fan motors—labor and material. Curve 4—cooling tower erection cost.

area where the exhaust air is not easily carried away by the wind.

The second design condition to be considered is the approach which is defined as the difference between the cold water temperature and the wet bulb temperature. It is desirable to attain as small an approach value as possible, however, a closer approach temperature is obtained by increasing the cooling tower size with a subsequent increase in tower cost. Also, the higher design wet bulb temperature selected, the easier it is to obtain a small approach value.

The cooling range is defined as the difference in temperature between the hot and cold water streams. The product of the cooling range times the water quantity in pounds per hour is the heat load to be handled by the cooling tower. In selecting the cooling range and water quantity, attention should be called to the fact that it is usually more economical to select a higher cooling range with a subsequent decreased water requirement than a smaller cooling range and a greater quantity of water. A factor of safety should not be applied to the cooling range, water rate, heat load or wet bulb temperature. These should be specified as close to the anticipated conditions as possible and a factor of safety then applied to the approach if desired.

ECONOMIC CONSIDERATIONS

Cooling towers are available in standard sizes which mean that blueprints are already available, fabrication procedures established and erection techniques perfected. Non-standard towers require additional design and draft-

ing cost, as well as special fabrication and erection. Therefore, it is usually better to select a standard tower size which can be supplied at a more economical price.

The usual method of evaluating a cooling tower installation consists of determining the annual cost of owning the equipment, based on a reasonable payout period, and including operating costs. The total cost of the tower is made up of the sum of the erected tower cost, basin, pump pit and pumping equipment. The cost of the power required to operate the unit is added to the depreciation and service charges in obtaining annual costs. In addition, it is necessary to consider those factors which will affect the performance of the tower. This type of analysis will provide answers to the inevitable question as to whether or not the lowest priced tower should be selected.

ESTIMATED COSTS

Much too often data are published as installed costs with no description of what is actually included in the scope of the installation. Labor costs, working conditions, design standards, and methods of installation of equipment vary with each location making it difficult to fit cost data of this type to a specific installation.

Cost data for induced draft cooling towers are shown in Figures 1, 2 and 3 as total direct installed costs versus capacity for the cooling tower, concrete basin and pump pit, fan motors, cooling tower erection, cooling water pumps, and manifold piping at the pumps. The summation of these costs, excluding pump and piping cost, are shown in Figure 1 based on an 83 F. wet bulb temperature, 7.5 F. approach, and a 26 F. cooling range. Correction factors must be applied to this cost for design conditions other than those shown. The factors relating the installed cooling tower cost shown in Figure 1 with performance are included in Figures 4, 5, and 6.

Scope. Before proceeding with an example of how these costs are applied in determining the total installed cost of cooling tower, some general comments are necessary to properly define the scope included in these costs.

Curve Number 1 of Figure 2 shows the purchased cost of an induced draft, wood filled, wood framed, and cased type cooling tower of heart redwood construction.

The structural framework of the tower including all

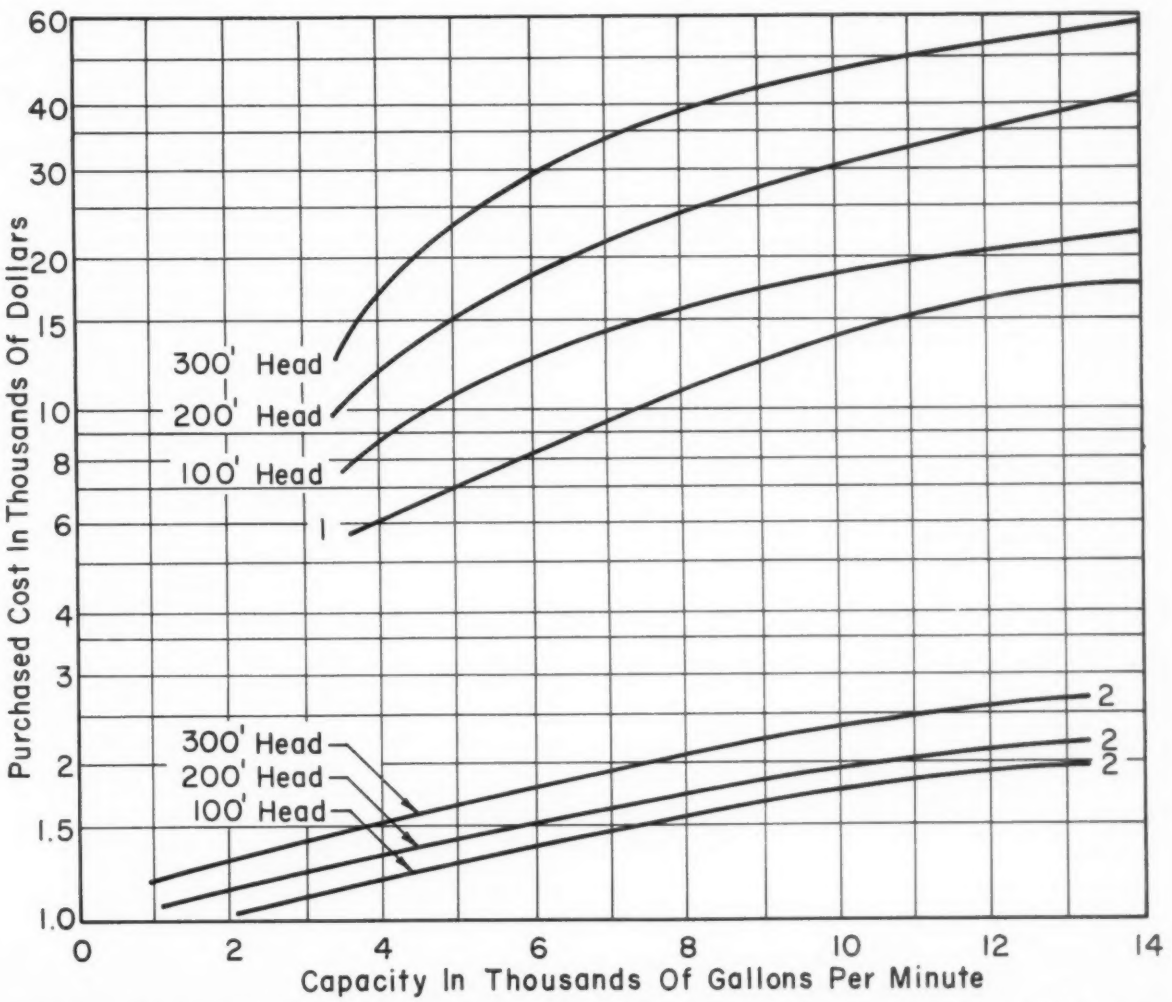

FIGURE 3—These costs are with pump and NEMA II motor and piping. Curve 1—piping cost—labor and material for one pump installation—for additional pump installations, use 75 percent of one pump installation cost. Curve 2—pump and motor installation cost including electrical for one pump motor—use 57 percent of one pump installation for each additional unit.

members and connections are designed to withstand a wind load of 30 pounds per square foot on the projected area.

Also included in this cost are the fans, reduction gear, primary hot water distribution system, and all prefabricated tower components shipped f.o.b. factory with freight allowed to customer's destination and supervision costs during erection and acceptance testing.

The fans included in the cooling tower cost are the axial flow, multi-blade type constructed of stainless steel with each blade adjustable as to degree of pitch and individually fastened to a common hub. The fan ring housing in the bell mouthed type fan stack and is constructed from laminated redwood. All fans greater than 10 feet in diameter are driven through a right angle speed reduction unit designed to allow operation in either direction. The gears are rated by the American Gear Manufacturer Association for a Class 2 service and allow a service factor of 1.25. A V-belt drive is included for fan sizes less than 10 feet in diameter. Normally the air flow will be set at approximately 350 feet per second through the tower with a limiting fan tip speed of 15,000 feet per minute.

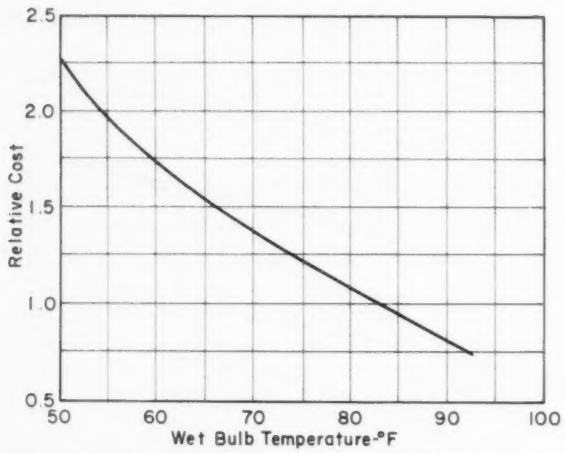

FIGURE 4—Use these correction factors for differences in wet bulb for Figure 1.

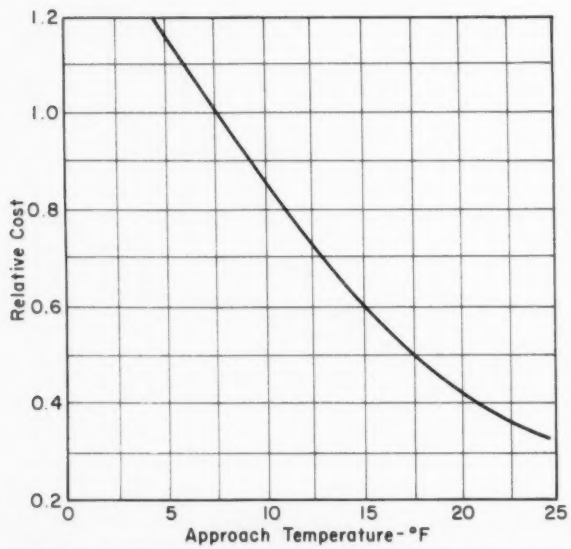

FIGURE 5—These correction factors apply to Figure 1 when the approach differs from 83 F W.B., 26 degrees cooling range, 7.5 F approach which equals 1.

The installed cost of the concrete tower basin and pump pit is shown by Curve Number 2 of Figure 2. All excavation, piling, concrete, reinforcing steel and backfill are included. The basin is approximately 4 feet greater in both length and width than the cooling tower proper and is sized to allow a 10 to 15 minute cold water storage time. Fifteen ton creosoted piles, 40 feet in length, are used to support the foundation load.

Curve Number 3, Figure 2, shows the total installed cost of the fan motors including combination starters and 50 feet of 440-volt, non-explosion-proof wiring and conduit from the motor control center. The motors are totally enclosed, three phase, squirrel cage, two speed, induction type. Two speed motors are specified to allow more flexible operation in cold weather since during this time it usually is possible to obtain the desired performance by operating at half speed which requires only about 20 percent of the full speed horsepower.

The cost of erecting the prefabricated cooling tower components on the concrete basin is shown by Curve Number 4 and is also incorporated in Figure 2. This cost includes receiving, unloading, hauling to the cooling tower site and erecting on the tower foundation together with the cost for setting the fans and the installation of the hot water distribution system.

The circulating pump and motor prices in relation to capacity and total discharge head for pump capacities to 14,000 gallons per minute of water and 300 feet head, installation cost, and the cost of the manifold piping at the pumps are shown in Figure 3. The pumps are multistage, vertical mixed flow impeller type with bronze construction and equipped with vertical hollow shaft, NEMA II motors. The installation costs are made up of the cost to set and test the pumps and motors in pump pit, 50 feet of electrical wiring and conduit from the substation to the motor and accessory fittings. Figure 3 shows the installed cost of piping, float valve for make-up water control, sump screen, anti-cavitation plate, drain and overflow connections. The main cooling water piping leading to or away from the tower is not included.

EXAMPLE 1

Estimate the cost of an induced draft cooling tower to handle 35,000 gpm of water entering at a temperature of 116.5 F. and leaving at a temperature of 90.5 F. The prevailing wet bulb temperature is 83 F. The pumping head will be 200 feet. Six pumps with a capacity of 7,000 gpm (each) will be installed providing one spare pump for the system. The approach temperature is 7.5 F.

From Figure 1 the total direct installed cost of the cooling tower, fan motors, concrete basin and pump pit is $315,000. The cost contributed by each item included in above cost, is shown in Figure 2. The purchased cost of the circulating pump and motor from Figure 3 is $21,000 each or a total of $126,000 for the six pumps required.

The total cost for the installation of one pump and motor from Figure 3 is $1,650. The cost of installing each additional pump and motor is 57 percent of the installation cost of one pump, making a total installation cost of $1,650 + 5 (1,650 × 0.57) = $6,352.

The installed cost of the manifold piping at the cooling tower, float valve for make-up water control, sump screen and anti-cavitation plates, drain and overflow connections are also shown in Figure 3 for the installation of one pump. The piping cost for each additional pump is 75 percent of the first pump manifold piping cost. The total piping cost is: $9,500 + 5 ($9,500 × 0.75) = $45,125.

Summary of Direct Installed Cooling Tower Costs:

Cooling tower, erection with fans, fan motors, and basin	$315,000
Circulating pumps and motors	126,000
Circulating pump and motor installation	6,352
Pump manifold piping	45,125
Total direct cost	$492,477

EXAMPLE II

Estimate the total direct installed cost for the same cooling tower used in Example I from the preliminary design information developed in this example.

Design Conditions: Same as Example I
Tower Size: 5 cells, 36 feet x 66 feet x 48 feet high
Basin Size: 70 feet x 184 feet x 3 feet deep, 1 foot walls, 1.5 feet floor, reinforced concrete
Pump & Motors: 450 hp, 2,300 volt, 60 cycle, NEMA II motors with vertical, multi-stage 7,000 gpm pumps at 200 feet discharge head
Fan Motors: 10-60 hp, TEFC, 2 speed, 1,800 rpm motors
Step 1—From Curve Number 1, Figure 2, the cost of the cooling tower including fans, gear reducers, freight and supervision during erection is: $178,000

Step 2—Basin & Foundation Cost

Foundation Load:

Tower (wet)	2,010,000 lbs.
Water (2′ deep)	1,485,000 lbs.
Basin (concrete and reinforcing steel)	3,212,650 lbs.
	6,707,650 lbs.

Piping: 15 ton creosoted piles
6,707,650/30,000 = 223 piles, 40′ long
Cost @ $4 per foot for contract job $ 35,700

Concrete: Ready mix delivered to pouring site
1.5 (184) 70 + 2 (70) 3 + 2 (184) 3
= 20,845 cu. ft.
= 772 cu. yds.

Cost: Concrete @ $13 cubic yard	$ 10,050
Labor 30 man-days @ $20/D	$ 600
Runways and Equipment	$ 775

Forms:
Floor: 2 (184) 1.5 + 2 (70) 1.5 = 762 sq. ft.
Walls: 4 (184) 3 + 4 (70) 3 = 3,050 sq. ft.
3,812 sq. ft.

Cost: Materials @ $0.42/sq. ft.	$ 1,600
Labor 66 man-days @ $30	$ 1,980

Reinforcing Steel:
Floor: ¾″ φ two ways, 12″ centers top and bottom
51,500′ = 77,200 lbs.
Walls: 16½″ φ rods
8,130′ = 5,450 lbs.

Cost: Materials: 82,650 lbs. @ $215 Ton	$ 8,900
Labor 75 man-days @ $25	$ 1,875

Excavation:

$$\frac{200' \times 85' \times 4'}{27} = 2{,}520 \text{ cu. yds.}$$

Cost: 1½ cu. yd. truck mounted crane: 45 hours @ $18.00	$ 810
Bulldozer: 45 hours @ $6.00	$ 270
4 Trucks: 45 hours @ $4.00	$ 720
Labor: 15 man-days @ $20.00	$ 300
Fuel and General Charges	$ 250

Back Fill and Grading: 610 cu. yd.

Cost: Bulldozer: 10 hours @ $6.00	$ 60
Labor: 25 man-days @ $18.00	$ 450

Basin Cost Summary

	Materials	Labor	Total
Piling (Contract)			$35,700
Concrete Basin	$21,575	$7,045	28,620
Total Direct Cost	$21,575	$7,045	$64,320
Cost Per Sq. Ft. Basin Area			$5.00

Step 3—Pump Pit Cost
Size: 45′ x 8′ x 10′ deep, 1′ walls 1½′ floor
Capacity: Six vertical pumps are installed each with a capacity of 7,000 gpm at 200′ head.

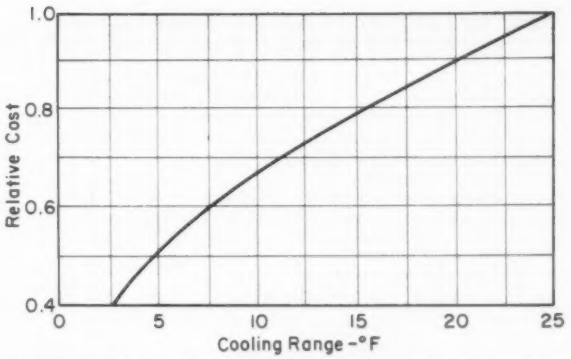

FIGURE 6—For different cooling range than in Figure 1 use these correction factors. Unity equals 83 F W.B. and 26 degree cooling range with 7.5 F approach.

Foundation Load: Six 7,000 gpm 200′ TDH Vertical Pumps, 450 hp Vertical Hollow Shaft Motors, 1160 rpm, 2300 V, 60 cycle motors. Five pumps operating.

Six Pumps @ 5,600 lb.	33,600 lbs.
Six Motors @ 4,800 lb.	28,800 lbs.
Thrust, 5 Pumps	105,000 lbs.
Water, 3,240 cu. ft.	202,000 lbs.
Pit (concrete and reinforcing steel)	362,850 lbs.
	732,250 lbs.

Piping: 15 Ton Creosoted Piles
732,250/30,000 = 25 piles 40′ long
Cost: @ $4.00 per foot for contract job $ 4,000

Concrete: Ready mixed delivered to pouring site.
1.5 (8) 45 + 2 (8) + 2 (45) 10 = 2,400 cu. ft.
= 89 cu. yds.

Cost: Concrete @ $13/cu. yd.	$ 1,156
Labor: 4 man-days @ $20.00	$ 80

Forms:
Floor: 2 (8) 1.5 + 2 (45) 1.5 = 159 sq. ft.
Walls: 4 (8) 10 + 4 (45) 10 = 2,120 sq. ft.
2,279 sq. ft.

Cost: Materials @ $0.42/sq. ft.	$ 956
Labor @ 39 man-days @ $30.00	$ 1,170

Reinforcing Steel:
Floor: ¾″ dia. two ways, 12″ centers top and bottom
1,440′ = 2,160 lbs.
Walls: 40½″ dia. rods
4,240′ = 2,850 lbs.

Cost: Material: 5,010 lb. @ $215/Ton	$ 538
Labor: 5 man-days @ $25.00	$ 125

Excavation:

$$\frac{65' \times 28' \times 10'}{27} = 675 \text{ cu. yds.}$$

Cost: Labor & Services proportional to cost for basis excavation	$ 625

Back Fill—540 cu. yds.

Cost: Bulldozer: 9 hours @ $6.00	$ 54
Labor: 22 man-days @ $18.00	$ 396

Pump Pit Cost Summary

	Materials	Labor	Total
Piling (Contract)			$ 4,000
Concrete Pit	$2,650	$2,450	5,100
Total Direct Cost	$2,650	$2,450	$ 9,100
Cost Per Sq. Ft. Pit Area			$25.28

Step 5—Fan Motor Installation

Cost of Fan Motors:

10-60 hp TEFC Motors: 10 x $1,850	$ 18,500
Labor: Crane 8 hours @ $7.50	$ 60
Total Direct Cost	$ 18,560

Cost of Electrical Wiring of Fans:
Cost for 10-60 hp Motors, non-explosion proof, 440 volt wiring from control center to motor-distance 50′

Materials:	
Combination Starters: $600 x 10	$ 6,000
Wire, conduit, fitting, etc.	$ 6,000
Labor:	
160 man-days @ $30.00	$ 4,800
	$ 16,800

Fan Motors and Wiring Cost Summary—Total 10 Fans

	Materials	Labor	Total
Motors	$18,500	$ 60	$18,560
Wiring	$12,000	$4,500	$16,500
Total Direct Costs	$30,500	$4,560	$35,060

Step 6—Circulating Pump Installation

Pumps: (6 installed)
7,000 gpm 200′ TDH all-bronze construction. Vertical well type mixed flow. Equipped with 450 hp, 1160 rpm, 2300 V, 60 cycle vertical hollow shaft motors.

Cost: Pumps @ $10,500 x 6	$ 63,000
Motors @ $10,500 x 6	$ 63,000
Labor: Crane 36 hours @ $7.50	$ 270
60 man-days @ $30.00	$ 1,800
Total Direct Cost	$128,070

Electrical Wiring of Motors:
Wiring from substation to motors distance 50′, 6-450 hp, 2300 V, 60 cycle, NEMA II motors.

Material:	
Cable, fittings, push buttons, etc.	$ 1,800
Labor: 80 man-days @ $30.00	$ 2,400
Total Direct Costs	$ 4,200

Step 7—Piping

Material: 18″ pump exits	
6—18″ IBBT flanged gates	$ 7,575
6—18″ IBBT flanged checks	$ 7,550
12—Fittings	$ 3,240
Series 150—WN flanges	$ 4,920
200′—20″ Sch. 40 pipe	$ 4,480
Float Valve, sump screen and anti-cavitation plate	$ 3,100
Labor: 500 man-days @ $30.00	$ 15,000
Total Direct Cost	$ 45,865

Pumping Station Cost Summary

	Materials	Labor	Total
Pumps and Motors	$126,000	$ 2,070	$128,070
Piping	$ 30,865	$15,000	$ 45,865
Wiring	$ 1,800	$ 2,400	$ 4,200
Total Direct Cost	$158,665	$19,470	$178,135

Step 8—Cost of Cooling Tower Erection

Receive Tower Components, load, haul and unload:	
Cost: 2 trucks: 40 hours @ $4.00 each	$ 320
Labor: 5 man-days @ $20.00	$ 1,000
Erect Tower on Foundation, set fans, gear reducers and distribution piping:	
Cost: Crane: 30 hours @ $7.50	$ 225
Labor: 1,050 man-days @ $25.00	$ 26,250
Total Direct Cost	$ 27,795

Summary of Direct Installed Cooling Tower Cost

Cooling Tower with Fans, Gears, Freight and Supervision	$178,000
Cooling Tower Basin	$ 64,320
Pump Pit	$ 9,100
Fan Motors and Wiring	$ 35,070
Circulating Pumps, Motors, and Wiring	$132,270
Manifold Piping at Pumps	$ 45,865
Cooling Tower Erection	$ 27,795
Total Direct Cost	$492,420

The cost of the cooling tower installation obtained using the preliminary design information is approximately $60.00 lower than the cost derived from the curves of Figures 2 and 3. The difference is less than one percent. No costs are included for design, overhead and contingencies since these costs will vary with each company. In addition, no costs are included for distribution services which include cooling water supply and return piping, electrical feeders and substations outside the cooling tower battery limits.

The cost presented in Figure 1 can be adjusted for cooling tower design conditions other than those shown with the use of the factors included in Figures 4, 5 and 6. These corrections are used to adjust the cooling tower price for different design wet bulb temperatures, approach, and cooling range. A third example is shown to illustrate how these factors are applied.

EXAMPLE III

Estimate the cost of an induced draft cooling tower to handle 35,000 gpm of water entering at 105 F. and leaving at a temperature of 85 F. The prevailing wet bulb temperature is 70 F. The pumping head is 200 feet. Six pumps with a capacity of 7,000 gpm (each) will be installed also providing one spare for the system. The approach temperature is 15 F. and the cooling range is 20 F.

From Figure 1, the total direct installed cost of the cooling tower excluding pumps, motors, and manifold piping is $315,000.

From Figure 4, the cost factor for a 70 F. wet bulb temperature is 1.4. The correction factor for a 15 F. approach from Figure 5 is 0.61. A final correction factor for the 20 F. cooling range obtained from Figure 6 is 0.9. Since the water rate is the same as that shown in Examples I and II, the total pump, motor and manifold piping installation will remain constant. The total direct cost for this cooling tower installation is summarized below:

Cooling Tower, Erection, with Fans, Motors and Basin	= $315,000 x 1.4 x 0.61 x 0.9 = $242,109
Circulating Pumps and Motors	= $126,000
Circulating Pump and Motor Installation	= $ 6,370
Pump Manifold Piping	= $215,125
Total Direct Cost	= $419,604

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New Processes Remove *n*-Paraffins

Two new processes, Texaco Selective Finishing process and UPO's Molex process, improve octane ratings of gasoline by removing inferior straight chain aliphatic hydrocarbons. Both use selective solid adsorbents and offer the refiner another method for upgrading the gasoline pool

1—The Texaco Selective Finishing Process

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MOST OF the stocks blended into gasoline contain a wide variety of hydrocarbon types, which show great differences in octane number. For any given molecular weight, the straight chain aliphatic hydrocarbons are the lowest in octane number. It is these components which are removed in the Texaco Selective Finishing Process, by means of a selective solid adsorbent, a so-called "molecular sieve."

Selective Finishing may be applied to a wide variety of stocks, so that it is a versatile process usable in many situations. The prime consideration in selecting a stock to be treated is that it contain low octane number straight chain components. Selective Finishing will upgrade in octane number such diversified stocks as catalytic reformate, light straight run naphtha, heavy FCC naphtha or even a heavy straight run naphtha.

Texaco Selective Finishing may be used to treat a catalytic reformate either to produce a higher octane number product at any given severity level, thereby raising the reformer octane ceiling, or to reduce the reformer severity required to produce a given octane number product, with the consequent increase in catalyst life. The process may also be applied to light stocks where higher front end octane number is desired. Selective Finishing is well adapted to use in conjunction with paraffin isomerization for removal of unconverted normal paraffins.

Unlike many other processes utilized for octane number improvement. Selective Finishing does not necessarily improve octane number by increasing aromatic concentration. This point becomes increasingly important as greater emphasis is placed on fuel sensitivity. The previously reported work[1] which evaluated the blending characteristics and road performance of Selectivity Finished light naphthas, showed that an appreciated type of blending was obtained with Finished light straight run naphtha and Finished light reformate. This positive blending deviation means that a small but significant octane credit could be obtained by use of Finished light naphthas in a premium gasoline blend. For maximum road octane performance, isoparaffinic fuels may be blended using Finished light naphthas to produce gasolines having 101-102 and higher (+ 3 cc TEL) Research Octane Number.

The Texaco Selective Finishing Process is a non-destructive process. The total quantity of liquid charge is recovered, separated into two streams of low and high octane number.[2,3,4] The low octane number components are separated and recovered for use in other products or recycle to the conversion process.

PROCESS DESCRIPTION

The essential part of the Texaco Selective Finishing Process is the sorbent used; a five Angstrom unit selective adsorbent. The selective adsorbent is a synthetic ziolite material whose unit cell has the form of a modified cube. Removal of the water of hydration leaves a void space within the unit cell, with access to the center gained through openings of fixed dimensions.[5,6,7]

In the particular version of Texaco Selective Finishing to be described, the operation is cyclic using

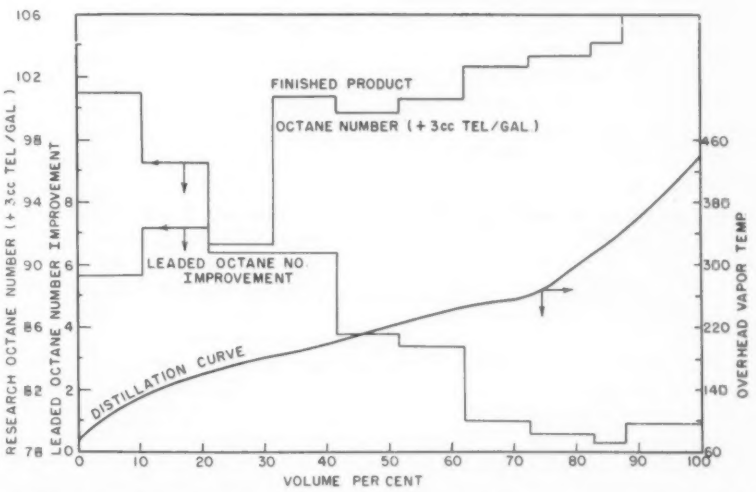

FIGURE 1—These octane improvements were obtained on ten percent fractions of 87 clear R.O.N. reformate. Notice how the octane improvement is greater on the front end of the fraction.

fixed beds of selective adsorbent. During the first part of the cycle, charge stock is passed over a bed of selective adsorbent until the void spaces in the crystal structure become filled with straight chain molecules.

When the bed of selective adsorbent becomes saturated with straight chain material, no further sorption can take place. At this point, the straight chain molecules will pass through the bed without being picked up by the adsorbent and begin to appear in the effluent product. Charge to the bed is then stopped and the second part of the cycle, desorption, is started. Removal of the material contained in the pores may be best accomplished by sweeping the bed with some vapor phase desorption medium. Light hydrocarbon vapors or fixed gases have been found to be suitable. The cycle is then repeated when all of the sorbed straight chain material has been removed.

OCTANE IMPROVEMENTS

Since the Texaco Selective Finishing Process operates by removing the low octane number straight chain hydrocarbons, the octane number improvement obtained in treating any stock will depend on the concentration of straight chain components (and also upon the composition of the remaining hydrocarbons). The data shown in Table 1 illustrates the response to Texaco Selective Finishing which might be expected of some typical refinery stocks. Leaded and clear Research Octane Numbers are shown for each of the stocks before and after Selective Finishing. The last column shows the increase in clear octane number obtained by Selective Finishing.

Straight Run Naphthas. Of the stocks shown, the straight run naphthas respond best to Finishing, with a 14.7 and 26.5 clear octane number improvement for light and heavy straight run naphtha respectively. The Finished light straight run naphtha leads to 96.6 Research Octane Number. The good response of these two stocks might be anticipated from the knowledge that they contain considerable quantities of normal paraffins.

Reformates. The response of two full boiling range catalytic reformates is shown next. These two stocks differ in octane number, the first having 87.1 while the second has 94.0 clear Research Octane Number prior to Selective Finishing. The difference in octane number, which reflects a difference in composition, causes the Finishing response to be reduced from 8.2 to 4.1 clear octane numbers. The higher octane number reformate, which contains fewer normal paraffins, shows less clear octane number increase. However, the leaded octane numbers of both Finished reformates are well above 100.

Thermal Cracked Naphtha. The next stock listed, thermal cracked naphtha, might also be expected to contain a considerable proportion of straight chain components. The response obtained, 13.1 numbers, approaches that of light straight run naphtha. The catalytically cracked naphthas, which would be expected to contain fewer straight chain hydrocarbons, show less response, although considerable improvement is obtained with heavy FCC naphtha.

In general, stocks will respond to Texaco Selective Finishing in proportion to their straight chain isomer content. This point is effectively illustrated by the data shown in Table 1 for reformate B and Aviation Alkylate. The clear octane numbers of these two stocks are quite similar, 94.0 and 93.1. However, the reformate shows a 4.1 number response while the alkylate shows essentially no response, since the half number shown lies within the reproducibility of the octane number determination. The polymer gasoline shows a response similar to that of the alkylate.

REFORMATE RESPONSE

In addition to finding that the best octane response is obtained with stocks containing the highest percentage of normal paraffins, it was found that different boiling range portions of a stock vary in their normal paraffin content, and hence in their response. Catalytic reformate is a typical case in question.

A sample of 87.0 clear Research Octane Number reformate was fractionated into ten approximately equal fractions. Each of the ten fractions obtained from this stock were then subjected to Selective Finishing, using vapor phase fixed bed contacting. The octane number of the product from treating each of the ten fractions was determined. The results are plotted in Figure 1.

The curve shows the vapor temperature of the column overhead as a function of the volume percent distilled. The lower series of stepped lines represents the difference in leaded Research Octane Number between the charge and Finished product for each of the ten percent cuts. The upper stepped lines show the leaded octane number of each of the ten percent fractions after Selective Finishing.

The greatest octane number response is shown by the front end of the reformate, with a 4 to 7 octane number improvement. The bottom end, which is largely aromatic, shows little improvement. Above 250 F. overhead vapor temperature, less than 1.0 octane number improvement could be obtained. However, the bottom end is already high in octane number and improvement here is not necessary. It is the low octane number front end which requires the greatest improvement and it is on these fractions that the greatest improvement is realized. Since the separation of catalytic reformate into light and heavy fractions is practiced in many instances, treatment of only the light stream, boiling below 250 F, would reduce the

TABLE 1—Response of Various Stocks to Texaco Selective Finishing

Stock	RESEARCH OCTANE NUMBERS				RON Increase (Clear)
	Charge to TSF		Finished Product		
	Clear	+3 cc TEL	Clear	+3 cc TEL	
Light Straight Run Naphtha	69.0	87.1	83.7	96.6	14.7
Heavy Straight Run Naphtha	44.1	66.4	70.6	....	26.5
Full Boiling Range Reformate A	87.1	97.1	95.3	101.1	8.2
Full Boiling Range Reformate B	94.0	100.8	98.1	104.0	4.1
Thermal Cracked Naphtha	76.0	88.5	89.1	96.1	13.1
Heavy FCC Naphtha	88.0	94.0	94.4	98.8	6.4
Light FCC Naphtha	93.8	99.2	95.7	100.6	1.9
Aviation Alkylate	93.1	104.4	93.6	....	0.5
Propylene Polymer Gasoline	93.0	98.0	93.6	98.6	0.6

feed to the Selective Finishing unit by almost 40 percent while maintaining essentially the same degree of upgrading basis the overall stock.

STRAIGHT RUN NAPHTHA RESPONSE

A similar evaluation of 10 percent fractions of a light straight run naphtha was also made. Texaco Selective Finishing Data on the ten percent fractions are plotted in Figure 2. Here again, the curve shows overhead vapor temperature while the lower and upper stepped lines show leaded octane number improvement and leaded octane number, respectively, of the Finished products.

Response of the light straight run naphtha differs from that of the catalytic reformate both in magnitude and uniformity. Octane number improvements ranging from 4.7 to 12 numbers were obtained over the entire boiling range of the stock, in contrast to the relatively poor octane number response shown by the heavy reformate. Octane numbers of the Finished fractions of the light straight run naphtha range from 92.2 to 101.5. While there are several possible ways to upgrade material in the light straight run naphtha boiling range, some of which involve separation into fractions, Texaco Selective Finishing offers promise of upgrading the entire stock in a single operation.

OPERATING CYCLE EVALUATION

The data discussed in the preceding section have shown that Texaco Selective Finishing is effective in upgrading light stocks. A process cycle was evaluated for a Selective Finishing operation charging a light stock, in this case taken to be a mixed hexanes stream similar to that which might be obtained from platinum catalyst isomerization. The data obtained show the feasibility of separating hexane isomers and demonstrate the operability of the Texaco Selective Finishing Process.

A charge stock containing 26.3 weight percent normal hexane and 73.7 weight percent isohexanes was processed in a single bed pilot unit. The equipment consisted basically of an electrically heated cylindrical vessel equipped with a pressure regulator and an outlet condenser. Two pumps with necessary connecting

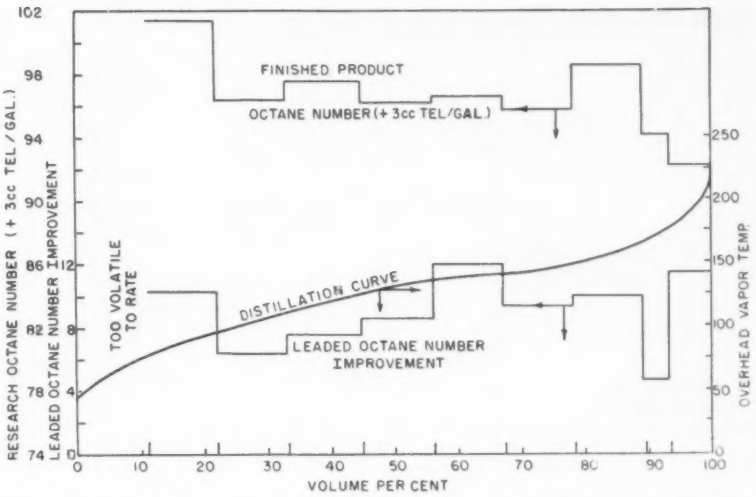

FIGURE 2—Straight run naphtha gave this response to Finishing. Notice how the octane improvement occurs throughout the entire distillation range.

lines and valves were employed, one for charging the mixed hexanes and another for charging the pentane desorption medium. The finishing agent bed was enclosed in a 1.5 inch ID stainless steel tube 70 inches long provided with an axial thermowell. The top five inches of the tubular vessel was packed with ⅜-inch steel balls and was used as a preheat section. Below the preheat section the bed of selective adsorbent extended for a depth of 65 inches and contained 1,280 grams of adsorbent having a volume of 1,700 cc. A pressure regulator was located on the discharge line from the vessel. A condenser consisting of a brine cooled, jacketed tube was connected to the discharge side of the pressure regulator.

A balanced vapor phase, isothermal, pressure-swing operating cycle at 600 F. was used in these experimental runs. Mixed hexanes were charged downflow to the bed at a rate of 1.0 liquid volume per hour per volume of adsorbent. The charge flow was stopped at a point where the bed was just short of saturation. The bed was then depressured to atmospheric pressure. Desorption was accomplished by charging pentane downflow to the bed at a rate of 0.75 liquid volume per hour per volume of adsorbent.

In the complete operating cycle mixed hexanes were charged to the bed for a 15-minute period, then the bed was depressured and desorption was accomplished in a 15-minute interval. The process was operated with a balanced cycle of approximately 30 minutes duration. Throughput of charge stock for these conditions was 0.5 volumes per hour per volume of selective adsorbent.

Outlet streams concentration and yield data obtained in 24 consecutive cycles are shown in Table 2. The isohexane product stream, the material collected in depressuring and the normal hexane desorbate stream of every 4th cycle were analyzed by gas chromatography. Yields and compositions of all streams were calculated on a pentane free basis. A composite blend which contained corresponding samples from each cycle was also prepared and analyzed.

These data show the degree of separation and yield attainable with the Texaco Selective Finishing Process. Work carried out with different charge stocks demonstrated that continuous operation could be carried beyond 2,000 cycles. The operation has also been carried out in a 10 bpd pilot unit.

In the present work, the composite sample of isohexane product over the 24 cycles had a purity of 98.5 percent and the desorbate contained 94.7 percent normal hexane. The material collected in depressuring contained substantial amounts of both iso and normal hexane. This stream could be recycled to either the Finished unit or the isomerization unit if it were desired to obtain only relatively pure product and desorption streams from the process.

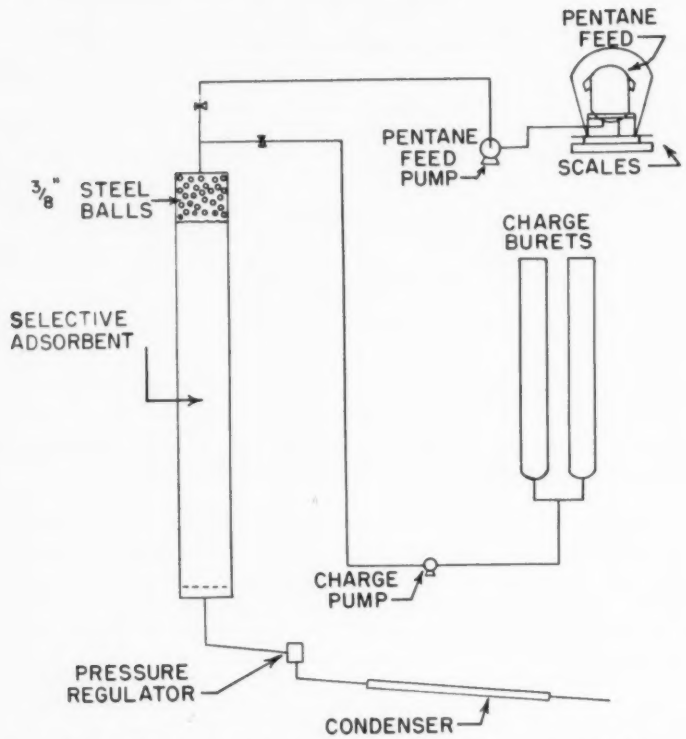

FIGURE 3—Charging a stock containing 26.3 weight percent normal hexane and 73.7 weight percent isohexanes to this single bed pilot unit gave the results shown in Table 2.

In certain situations it might not be necessary to obtain a high purity product, and the depressure and products streams could possibly be combined.

The Texaco Selective Finishing Process will efficiently separate hydrocarbon mixtures into normal paraffin and mixed isomer fractions of fairly high purity. In these runs with a stock containing 26.3 percent normal hexane, a product yield of 67.0 percent represents 90 percent of the maximum possible product yield. The 10.3 percent yield of material with a high normal paraffin content obtained in depressuring could be recycled to the Selective Finishing unit resulting in complete separation into product and desorbate streams. If this were done, the throughput would be reduced from 0.5 to 0.44 volumes per hour per volume of adsorbent.

ECONOMIC DATA

Cost data were calculated for the Selective Finishing Cycle described in the preceding section for hexanes separation, since economic considerations are an important part of any process. For purposes of the calculation, a two bed system was used, rather than the single bed of the process cycle evaluation. The balanced pressure swing cycle was employed. A flow sheet for such an arrangement is shown in Figure 4.

During the sorption period, fresh charge is exchanged against the vessel effluent, then further heated to 325 F. before charging to the bed of selective adsorbent. Additional heating is accomplished within the bed by the liberation of the heat of sorption of the normal hexane contained in the charge stock. Although the heats of sorption and desorption were not large enough to cause any significant departure from isothermal operation in the pilot unit of the preceding section, the effect may be large enough to increase the bed temperature significantly during sorption in a larger commercial unit. However, in adiabatic operations, heat generated within the bed would tend to compensate for natural heat losses and help maintain vapor phase operation. The heat balance of the cycle can be regulated by varying the temperature of the hexanes charge and the pentane desorption medium.

At the start of sorption, the vessel is at desorption pressure, 20 psig. Charge stock is pumped into the vessel with no product withdrawal until the sorption operating pressure is reached, here chosen to be 100 psig. This pressure is then maintained by the withdrawal of normal hexane free product, until the desired degree of bed saturation is obtained. In this economic study, a sorption period of 20 minutes was assumed. At the conclusion of this period charge to the first vessel is switched to a second vessel which has just completed its desorption period.

The actual desorption period is preceded by a depressure period of short duration, wherein the pressure is reduced from the 100 psig sorption pressure to 20 psig desorption pressure. Then desorption medium, in this case isopentane, is pumped over the bed until all of the sorbed normal hexane is removed. The total elapsed time for the depressure plus desorption periods was taken to be equal to the 20-minute sorption period.

The desorption medium is heated to 800 F. to supply the required heat of desorption and to obtain some slight temperature rise in the bed. After exchange with incoming fresh desorption medium, the effluent is

TABLE 2—Composition and Yields of Texaco Selective Finishing Process Streams

Cycle		Normal Hexane (Wt percent)	Isohexanes (Wt percent)	Yield (Wt percent)
4	Product Stream	1.2	98.7	66.2
	Depressure Stream.	42.4	57.6	8.0
	Desorption Stream.	94.8	5.2	21.6
8	Product Stream	1.6	98.3	66.2
	Depressure Stream.	35.8	64.1	10.1
	Desorption Stream.	93.6	7.3	21.7
12	Product Stream	1.8	98.3	68.6
	Depressure Stream.	36.5	63.4	10.7
	Desorption Stream.	93.6	6.3	20.8
16	Product Stream	1.7	98.2	69.2
	Depressure Stream.	38.9	61.2	8.2
	Desorption Stream.	93.4	6.5	23.2
20	Product Stream	2.0	97.9	64.4
	Depressure Stream.	37.4	62.6	10.8
	Desorption Stream.	94.5	5.7	18.5
24	Product Stream	1.7	98.2	65.6
	Depressure Stream.	31.6	68.6	13.1
	Desorption Stream.	93.4	6.8	22.2
Composite Sample	Product Stream	1.4	98.5	67.0
	Depressure Stream.	31.6	68.3	10.3
	Desorption Stream.	94.7	5.3	21.2

stripped to recover normal paraffins and isopentane for recycle. Although the desorption medium shown is isopentane, other light hydrocarbons which could be easily stripped, such as normal pentane, isobutane, or normal butane, could be used. Estimated cost data calculated on the basis of the cycle described are shown in Table 3. A total processing cost of $0.273/bbl. is shown for an assumed 6660 BPCD plant size. Of this figure, $0.047/bbl. are fixed charges. Included in these fixed charges is a depreciation allowance on the estimated investment of $1,900,000. Charges for labor plus materials and supplies amount to $0.047/bbl. This leaves some $0.179/bbl. operating expenses. A large fraction of the operating expenses is the chemicals charge, which is the cost of 120,000 lbs of selective adsorbent charged to each processing vessel. In arriving at a figure for this cost, a price of $1.00/lb was used, to give a total chemicals charge of $240,000. This calculates to $0.099/bbl. on the assumption of a one year adsorbent life, which is felt to be a conservative estimate. Any reduction in cost or increase in life would result in a lower total operating cost for the Texaco Selective Finishing Process.

In order to obtain a more meaningful figure, the cost of the improvement to the entire gasoline pool, in terms of dollars per octane gallon, which might be obtained by installation of Texaco Selective Finishing was estimated. To approximate a realistic situation under such conditions, it was postulated that the Selective Finishing unit be operated in conjunction with high temperature hexane isomerization, such as platinum catalyst isomerization.

TABLE 3—Estimated Cost Calculations for Texaco Selective Finishing 6660 BPCD Mixed Hexanes Charge

Estimated Expenses	Unit Amount ($/bbl.)
Labor plus Materials and Supplies	$0.047
Utilities	0.080
Chemicals	0.099
Total Operating	0.179
Total Fixed Charges	0.047
Total (ex indirect and general overhead)	0.273

TABLE 4—Estimate Processing Costs for Texaco Selective Finishing

Charges	Amount		
Motor Gasoline Loss due Isomerization	$ 761		
Expenses–TSF and Incremental Isomerization	2409		
Total Charges	3170		
Credits–TEL Saved and By-Products	423		
Differences (Charges–Credits)	2747		
Cost of Increasing Octane Number		Pot Octane Number Before TSF	Pot Octane Number After TSF
		97.5	98.324
Motor Gasoline Pot	$32,880		
Cost per Research Octane-Gallon	2747 / 32,880 x 42 x 0.0824 = $0.00241		

The cycle shown in the flow diagram, which is the one on which the cost data are based, assumed 22 percent normal hexane in the hexane isomerate. The normal hexane desorbate could then be recycled to the isomerization reactor. The improvement to the total gasoline pool which could be realized by blending the higher octane number Finished product was calculated and the cost data applied to determine the cost per octane gallon. A summary of these calculations is shown in Table 4.

The $761 charge shown for motor gasoline loss represents the yield penalty incurred in the isomerization step, since Selective Finishing is essentially a no-loss operation. The unit cost, $0.273 per barrel, used in calculating the charge for the Selective Finishing operation is based on the $1.00/lb cost for the selective adsorbent. Any reduction in price or increase in life for the selective adsorbent would reduce this cost. Added to this Selective Finishing Cost is the incremental isomerization cost due to the additional isomerization processing necessitated by the recycle stream.

Blending the 216 bph of isohexanes product into an assumed 32,880 bpcd gasoline pot increases its octane number by better than 0.8 research octane number. The cost of this increase calculates out to be $0.00241/octane gallon. This cost compares favorably with other gasoline processes on a research octane basis. In addition, fuels containing Finished stocks show improved road octane performance which is difficult to take into account in arriving at a dollar comparison with any other process.

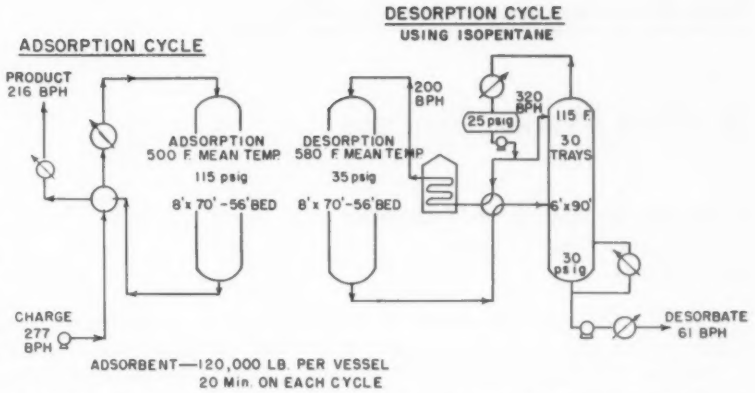

FIGURE 4—A two bed system such as this was used for economic calculations giving the data shown in Tables 3 and 4.

CONCLUSIONS

1. Texaco Selective Finishing is effective in improving the octane number of full boiling range or light catalytic reformates, light straight run naphthas and isomerate stocks.

2. Efficient separation has been demonstrated.

3. Processing costs, when calculated for application of Selective Finishing to a hexane isomerate stream, appear reasonable.

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2—The Molex Process

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Even the best gasolines marketed today contain appreciable quantities of normal paraffins—materials so inferior that they are used as the lower standard on the octane performance scale. The Molex process of UOP provides the industry with a practical tool for the clean removal of these low quality components.

Normal paraffins occur throughout the entire gasoline boiling range. Of these only the lightest, normal butane, has acceptable quality by today's octane number standards. As the molecular weight of the normal paraffin increases, its engine performance deteriorates rapidly. Figure 1, a plot of the leaded Research octane number of normal paraffins versus the size of the normal paraffin molecule, shows graphically this deterioration.

A large proportion of the normal paraffins generally found in gasolines are derived from the light straight run and natural gasoline fractions which usually are not subjected to any processing other than fractionation. Normal paraffins spread throughout the boiling range also are present even in the most highly reformed gasolines. Figure 2 shows how the normal paraffin content of a reformate produced from a typical Mid-Continent naphtha varies with the severity of the reforming. Note that there is always an appreciable percentage of heptane and heavier normal paraffins, and that as reforming severity increases, the amount of normal pentane and normal hexane increases.

Because normal paraffins are spead throughout the entire boiling range and because the concentration of each particular normal paraffin is low, separation by fractionation has generally been considered to be impractical. Molex will perform the heretofore impractical removal of normal paraffins as a class in one economical operation.

When faced with customer complaints on antiknock performance, refiners have in general resorted to producing gasoline having sufficient aromaticity to mask the adverse effect of the normal paraffins. This is, however, only a partial solution. The customer has only his own vehicle as an octane-test machine. A highly aromatic fuel, despite its high Research octane rating, does not necessarily perform well in the customer's engine because his engine responds to an octane number somewhere between the Research and the Motor method ratings. One sees recognition of this in the requirement of lower sensitivity for pipeline gasoline. By the removal of the poorest class of hydrocarbons usually found in gasoline, Molex enables the refiner to produce a gasoline of lower aromatic content—therefore of lower sensitivity—for a given Research octane number rating. The gasoline of lower aromatic content has an additional advantage, in that it is cleaner burning than fuels of high aromatic content. Consequently, an engine using the lower aromatic fuel will demonstrate a lower octane requirement increase.

The Molex process separates all of the normal paraffins as a group from the other types of hydrocarbons through the use of "molecular sieves." Although the affinity of such materials for normal paraffins has long been known, having first been discovered in the naturally occurring mineral Chabazite, the practical problems inherent in the use of such adsorbents have prevented commerical application for hydrocarbon type separation.

The objectives in developing the Molex process were:

- First, to develop a process which would remove normal paraffins throughout the gasoline boiling range in a single treatment;
- Second, to develop a continuous process;
- Third, to develop such a process capable of clean separations using a minimum of utilities.

These objectives have been realized. Figure 3 shows the Molex flow. Basically the unit consists of a primary separation section and a secondary separation section.

In the Molex process, the separation is carried out under conditions which are easily incorporated into normal refining operations. The adsorbent is used in a fixed bed isothermal manner, and feed and separated product streams are uniform and continuous. Temperatures and pressures are moderate and ordinary materials of construction are satisfactory. The use of this new process thus permits refiners to easily and economically remove the objectionable normal paraffins from their gasoline products, and, by the use of other available processes, such as Penex and Platforming, convert them into desirable gasoline constituents.

With regard to the applications of the Molex process, there are occasions on which it is not competitive with fractionation, other occasions on which it is very definitely superior to fractionation, and still other occasions on which it will perform a separation impossible by fractionation. In a separation such as isobutane from normal butane, or isopentane from normal pentane, the choice between fractionation and Molex will depend upon factors such as concentration, capacity and product purity. On more complex hydrocarbon mixtures, such as a pentane-hexane mixture, Molex presents pronounced technical and economic advantages.

A UOP Molex pilot plant has demonstrated its reliability with steady operation over extended periods of time, and from which much of the data to be presented in this paper has been developed.

Table 1 gives results which were obtained in pilot plant operation with three different mixtures of C_5

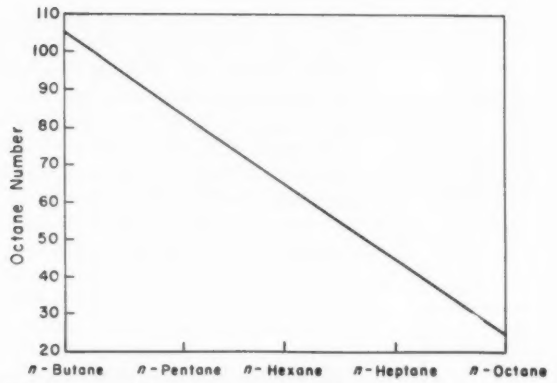

FIGURE 1—(above) As the normal paraffin hydrocarbon becomes larger its leaded R.O.N. decreases.

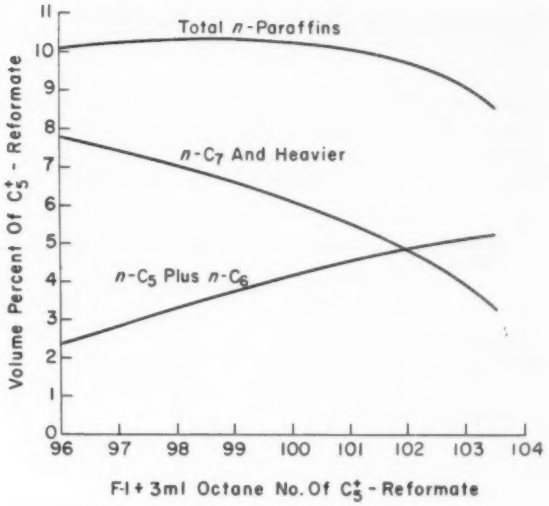

FIGURE 2—(upper right) Shows how the normal paraffin content of a reformate produced from a typical Mid-Continent naphtha varies with the severity of the reforming. Note that normal pentane and normal hexane content increases with severity.

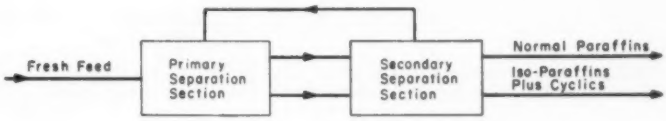

FIGURE 3—(lower right) Block diagram of the Molex process showing relation of primary and secondary separation sections.

and C_6 hydrocarbons. These stocks are first, a mixture of C_6 paraffins; second, a mixture of C_5 and C_6 paraffins and, third, a light extract cut of Rexformate which has olefins and aromatics present in addition to the paraffins. In each case the pilot plant performed a very respectable separation, one that fractionation would be hard pressed to equal.

Economics. An important question, of course, is the economics of the Molex application. Qualitatively, in any separation of normal paraffins from other hydrocarbons Molex will consume less utilities than fractionation. For less difficult separations, the installed cost of Molex will be higher. Another generality is that as increasingly precise separations are desired by fractionation, the investment and utilities requirements for a given capacity increase sharply. This is not true of Molex. Moreover, many separations are so complex that they cannot be accomplished with fractionation, but can be made readily with Molex.

Still another economic factor which must be considerered in comparing Molex and fractionation for stocks of the type shown in Table 1 is the eventual destination of the normal pentane and normal hexane product. It is believed that these materials will find their principal outlet by isomerization to high octane, low sensitivity gasoline, employing processes such as Penex. In this type of processing, when fractionation is used to separate the isomerized products from unconverted normal hexane, C_6 cyclics tend to remain with the recycle normal hexane. Consequently, the recycle builds up in cyclic content to the point where a considerably larger isomerization unit is required. This problem does not arise when Molex separation is used, since in this case cyclics remain with the iso-paraffins. The saving in isomerization investment cost can be credited to the Molex investment.

The economic comparison shown in Table 2 uses as a basis a pentane-hexane mixture of the type shown as Stock B in Table 1. Steam cost has been taken on the basis of $0.35 per 1000 pounds. The fresh stock charge rate has been taken as 2500 B/D. By either route, Penex plus fractionation or Penex plus Molex,

TABLE 1—Pilot Plant Separations on Pentane-Hexane Stocks

	Stock A—Nat. Gaso. Hexanes			Stock B—Nat. Gaso. C_5+C_6			Stock C—Light Rexformate		
	Feed	Denorm. Product	Normal Product	Feed	Denorm. Product	Normal Product	Feed	Denorm. Product	Normal Product
Analysis, Wt. Percent									
nC_5	0.0	0.0	0.0	17.5	0.4	41.2	23.0	1.7	70.3
nC_6	39.1	0.7	99.2	25.3	0.6	57.6	8.5	0.3	25.9
Iso-paraffins	51.8	84.4	0.7	51.5	88.2	1.1	54.0	78.1	1.7
Naphthenes	9.1	14.9	0.1	5.7	10.8	0.1	6.5	9.3	0.2
Aromatics	0.0	0.0	0.0	0.0	0.0	0.0	4.9	7.0	0.1
Olefins	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.6	1.8
Total n-paraffins, Wt. Percent	39.1	0.7	99.2	42.8	1.0	98.8	31.5	2.0	96.2
Octane Number									
F-1 Cl	61.4	79.5	28.0	66.8	84.1	46.0	78.6	90.0	56.7
F-1+3ml	84.4	96.0	63.7	87.4	98.4	72.9	94.5	102.0	80.8
F-2 Cl	59.4	80.4	25.3	....	83.6	41.9	76.0	85.9	53.3
F-2+3ml	85.3	97.4	65.3	....	101.2	75.1	95.1	101.2	....

TABLE 2—Economic Comparison of Fractionation With Molex Penex Isomerization of 2500 B/D of Mixed Pentanes and Hexanes to 100.3 F-1 Plus 3 ml

Investment Cost	Penex With Fractionation	Penex With Molex
Penex Unit	$ 780,000	$ 650,000
Separation Unit	900,000	855,000
Total:	1,680,000	1,505,000
Operating Cost, Dollars/Day		
Labor and Adminstration	267	267
Steam	640	240
Fuel	80	72
Cooling Water	75	30
Power	84	63
Sieve Replacement	.....	150
Maintenance	145	130
Local Taxes and Insurance	121	108
Total:	1,412	1,060
Yields		
Isomerized Product, B/D	2,417	2,455
Fuel Gas, 10^6 BTU/D	573	298
Value of Incremental Yield, Dollars/Day		
Isomerized Product	.....	239
Fuel Gas	55	.....

a total product having a leaded Research octane number of 100.3 is made. The over-all yield is slightly better for the Penex plus Molex operation, resulting in a credit for this case.

Table 2 shows that the Penex plus Molex case not only represents an investment of $175,000 less than Penex plus fractionation, but in addition operates for $352 a day less and produces an additional $184 per day of product. In its pilot plant experience, UOP has operated for extended periods on this type of stock with no significant deterioration in sieve activity. The replacement cost of sieves in Table 2 is believed to be a conservative extension of the operating life demonstrated in the pilot plant.

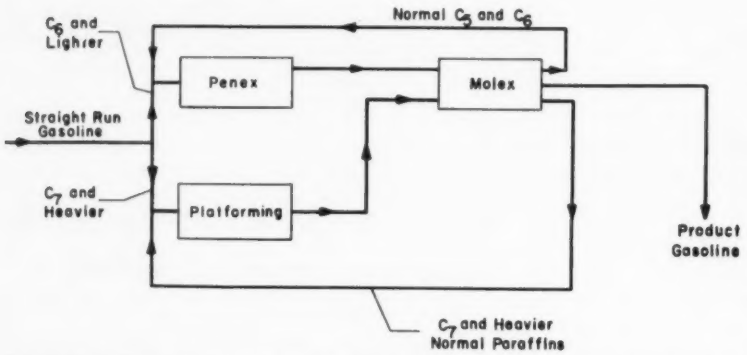

FIGURE 4—For processing a straight run gasoline to its ultimate octane number this combination of reforming, isomerization and Molex can be used.

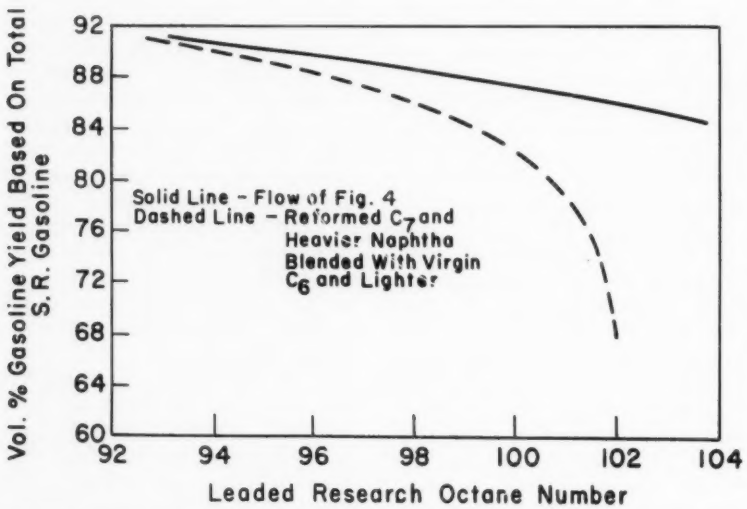

FIGURE 5—Liquid volume yields for reforming versus reforming with isomerization and Molex.

TABLE 3—Pilot Plant Separations on Gasoline Boiling Range Stocks

	REFORMATE STOCK D			REFORMATE STOCK E			STRAIGHT RUN STOCK F		
	Feed	Denorm. Product	Normal Product	Feed	Denorm. Product	Normal Product	Feed	Denorm. Product	Normal Product
Vol. Percent Aroms	53	....	....	57	....	....	4	....	....
ASTM Distn.									
I.B.P.	120	....	....	142	....	....	220	....	....
10 Percent	166	....	....	178	....	....	250	....	....
50 Percent	250	....	....	230	....	....	280	....	....
90 Percent	331	....	....	292	....	....	317	....	....
E.P.	420	....	....	352	....	....	363	....	....
Wt. Percent n-Paraffins									
C_5	4.4	0.4	37.1	2.7	0.2	25.4	0.0	0.0	0.0
C_6	3.8	0.5	30.6	3.7	0.4	33.6	0.7	0.1	2.2
C_7	2.9	0.6	21.6	3.5	0.7	28.8	3.2	0.2	10.8
C_8	....	....	....	....	....	....	11.2	0.4	38.3
C_9	1.3	0.3	9.4	1.1	0.4	7.4	9.9	1.9	30.0
C_{10+}	....	....	....	....	....	....	3.9	0.8	11.7
Total n-Paraffins, Wt. Percent	12.4	1.8	98.7	11.0	1.7	95.2	28.9	3.4	93.0
F-1 Clear O.N.	89.5	95.0	35.3	93.6	99.1	37.0	20.9	38.7	<0
F-1+3ml O.N.	98.2	101.3	65.3	101.2	104.9	65.2	53.8	65.7	10.3

Upgrading Reformate. It has been shown previously that removal of normal pentane and normal hexane from light hydrocarbon cuts by Molex is both feasible and economic when compared with conventional fractionation. Let us now consider how Molex might be applied to upgrading the product from catalytic reforming. All catalytic reformates contain C_5 through C_9 normal paraffins. Usually the amount of normal pentane plus normal hexane exceeds the sum of all the heavier normal paraffins. However, as the molecular weight of the normal paraffin increases, the octane number becomes rapidly worse so that the removal of the C_7 and heavier normal paraffins is important from a quality standpoint. A separation of all normal paraffins from a reformate by fractionation is not practical; by Molex the separation is accomplished readily in one operation. This is shown by the pilot plant results tabulated in Table 3. Also included in Table 3 are results of a Molex separation on the straight run stock to demonstrate the ability of the process to handle heavier normal paraffin components in higher concentrations.

Molex can be used in conjunction with catalytic reforming in several ways. It is of interest to investigate whether the addition of a Molex unit to a catalytic reforming unit has attractive economics. Consider the case of a refiner whose catalytic reformer is operating at its maximum severity for the required capacity. This refiner could remove heavy normal paraffins from his reformate by the addition of Molex, thereby increasing its octane rating.

It is also assumed that this refiner is not yet in need of the ultimate octane attainable through the use of an integrated isomerization, reforming and Molex operation.

Therefore, only the heptane and heavier reformate is charged to the Molex and only the heptane and heavier normal paraffins are removed from the final reformate. In evaluating the products from the Molex unit, gasoline price has been based on the 1958 edition of Platt's Oil Price Handbook, Gulf Coast low cargo price, and normal paraffins at light fuel oil price. Table 4 presents the economics of Molex in this situation.

As Table 4 demonstrates, this application of Molex pays out readily. In this application the pilot plant has operated for an extended period with insignificant decline in sieve activity. The sieve life assumed for this application is a conservative extension of demonstrated life.

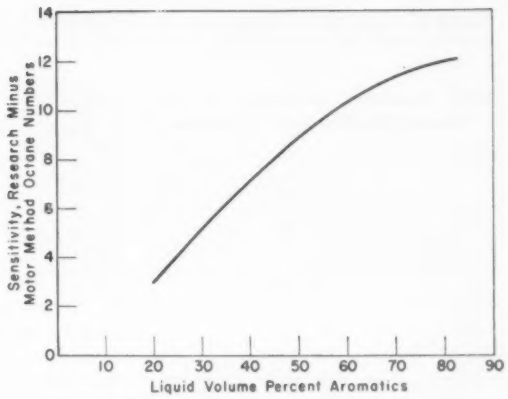

FIGURE 6—Shows how the sensitivity of a reformed gasoline varies with the aromatics content.

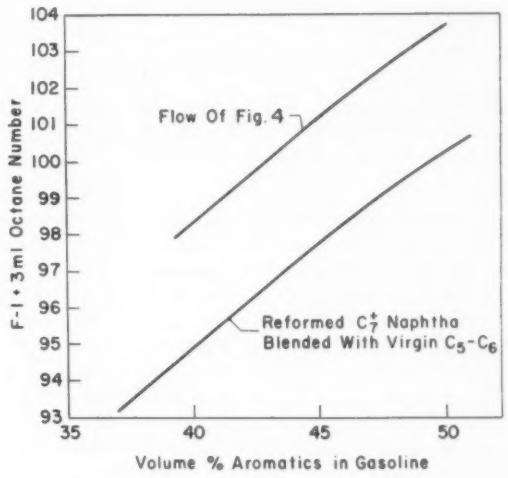

FIGURE 7—Shows that at any fixed reforming severity, the addition of Penex and Molex facilities will give the refiner a potential increase of from 3 to 4 leaded R.O.N on this Mid-Continent stock.

Straight Run Gasoline. Consider now the processing of a straight run gasoline to its ultimate octane number. In this case catalytic reforming, isomerization and Molex are employed as shown in Figure 4.

The anticipated performance of this combination on a typical C_5 and heavier Mid-Continent straight run gasoline is shown on Figure 5 as a plot of liquid yield based on straight run vs. leaded Research octane number of the produced gasoline. A dashed line is shown to represent the performance of a system in which the C_7 and heavier portion of the straight run stock is reformed and then blended with the virgin C_5 and C_6 material to give the gasoline product.

It can be seen from Figure 5 that the flow scheme of Figure 4 gives increasingly higher yields of gasoline than only reforming as octane goals are set higher.

Since the ultimate leaded octane number of the total gasoline (reformate blended with the virgin C_5 and C_6 material) produced when reforming only is used is about 102, economic comparisons above this level, or even approaching it, are meaningless. The economics of the addition of Penex and Molex to a catalytic reformer have been evaluated on the basis of a fixed reforming severity.

Employing the processing arrangement of Figure 4 on a typical Mid-Continent straight run gasoline containing 10.4 liquid volume percent C_5 and 14.2 liquid volume percent C_6, the economic data shown in Table 5 have been developed.

In preparing Table 5, it has been presumed that the Penex and Molex facilities are to be added to a catalytic reformer capable of reaching 93 F-1 clear octane number. The addition of these facilities shows a very attractive payout. Actually, this straight run gasoline could be processed to higher final octane number if the reformer is operated at higher severity. Economics of such a case are necessarily vague because of the absence of quoted prices on gasoline at octanes above 102. At reformer severities below 93, the economics of Molex plus isomerization are still attractive; for instance, on this stock at 85 F-1 clear octane reformate a payout time of 1½ years is indicated.

Normal Paraffin Uses. It is apparent from Figure 2 that substantial quantities of normal paraffins, heptane and heavier, can be made available as a by-product of Molex treatment of reformates. This is an entirely new product from the industry, for which special uses may well develop. For example, these normal paraffins could be the starting point for synthesis of straight chain organic compounds of various types, such as aldehydes and alcohols. Certainly they would be a preferred stock for high temperature pyrolysis to make ethylene, etc., since normal paraffins are easily cracked. Another unique property of normal paraffins is that they demonstrate the highest heat of combustion per pound of any hydrocarbon. This property should be of value in preparing fuels for aeronautical purposes—jet or misile fuels. These normal paraffins can of course be recycled to the reformer as in our example, but it is predicted that, due to their specific chemical and physical properties, they will ultimately be of greater value in other applications.

Additional Benefits. The major product of any of the foregoing

TABLE 4—Molex Separation of C_7+ Normal Paraffins From Reformate

	B/D	F-1+3ml Octane No.	Value, ¢/Gal.	Value, $/Day
Charge	5,000	96.0	11.75	24,675
Denormal Product	4,570	99.1	13.19	25,317
Normal Product	430	....	9.63	1,739
Increase In Value	....	....	....	2,381
Molex—Installed Cost		$800,000		
Operating Cost, $/Day				
Labor and Administration	....	....	138	....
Steam	....	....	120	....
Fuel	....	....	15	....
Cooling Water	....	....	26	....
Power	....	....	8	....
Sieve Replacement	....	....	218	....
Maintenance	....	....	70	....
Local Taxes and Insurance	....	....	59	....
Total:	....	....	654	....
Gross Profit, $/Day	....	....	1,727	....
Payout, Before Taxes and Before Royalty, Years	....	....	1.27	

schemes applying Molex is gasoline. The gasolines so produced will have compositions different from gasolines as we know them today. The economic data which has been presented is based solely on Research octane numbers, but the benefit to the refiner from Molex goes beyond Research octane number economics. Molex is a tool for lowering the aromatic content of gasolines while maintaining high Research octane number, thus lowering the sensitivity and the octane requirement increase. These are the other things which the ultimate consumer will notice in his automobile, in addition to the Research octane number.

Lower Sensitivity. The sensitivity of a reformed gasoline increases with increases in the aromatics content. This approximate relationship holds for reformed gasolines including C_5 and C_6 in varying amounts regardless of charge stock source. Through the use of Molex the refiner is able to eliminate the worst paraffinic components from his product. For a given Research octane number, he therefore requires a lower aromatic content since the average quality of the paraffins is improved. The lower aromatic content results in a lower sensitivity. For the full range Mid-Continent naphtha assumed in the development of Table 5, the relationship between aromatics content and leaded Research octane number is shown in Figure 7. Curves are shown for the case of Platforming only and the case of Platforming plus Molex plus Penex. It is apparent from these curves that at a constant Research octane rating a reduction of aromatics content of from 5 to 7 percent, depending on octane level, is accomplished by the use of Molex and Penex in conjunction with Platforming. Figure 6 shows that this reduction in aromatics content results in lower sensitivity by approximately one full number.

TABLE 5—Economics of Catalytic Reforming Plus Isomerization Plus Molex

Basis: Reforming Mid-Continent Naphtha to 93 F-1 Clear Octane Number, 100,000 B/D of Full Range Straight Run Gasoline

	Reforming	Reforming Plus Isomerization Plus Molex
Product Gasoline Including Light Straight Run		
F-1 + 3 m. Octane Number	96.9	102.1
Barrels/Day	8,776	8,580
Value, ¢/Gal	12.10	15.56
Value, $/Day	44,600	56,071
Incremental Product Value, $/Day	....	11,471
Incremental Operating Cost, $/Day	....	1,710
Gross Profit, $/Day	....	9,761
Incremental Investment	....	$2,411,000
Payout On Incremental Investment Before Taxes and Royalty, Years	....	0.68

Ultimate Quality. In planning new facilities, a refiner is always interested in the ultimate quality of product the facilities can produce. The ultimate leaded Research octane number which can be produced from the Mid-Continent naphtha when Platforming is the octane upgrading process involved only is about 102; Platforming plus Molex and Penex produces at ultimate severity a gasoline of about 105 octane number. Figure 7 shows that at any fixed Platforming severity, the addition of Penex and Molex facilities will give the refiner a potential increase of from 3 to 4 leaded Research numbers on this Mid-Continent stock.

In conclusion, UOP now offers to the industry a process to accomplish separation of normal paraffins as a class from narrow cuts or from full boiling range gasolines. The process has been shown to be economic not only when in competition with fractionation but also when called on to perform separations impossible with fractionation. It enables the refiner to produce gasoline of lower sensitivity than he can now produce.

Alternately Molex enables the refiner to raise the Research octane rating of his gasoline without increasing sensitivity. Extensive pilot plant work, which developed the data presented here, has demonstrated the technical practicality of the process. This process is a major step forward in separation techniques.

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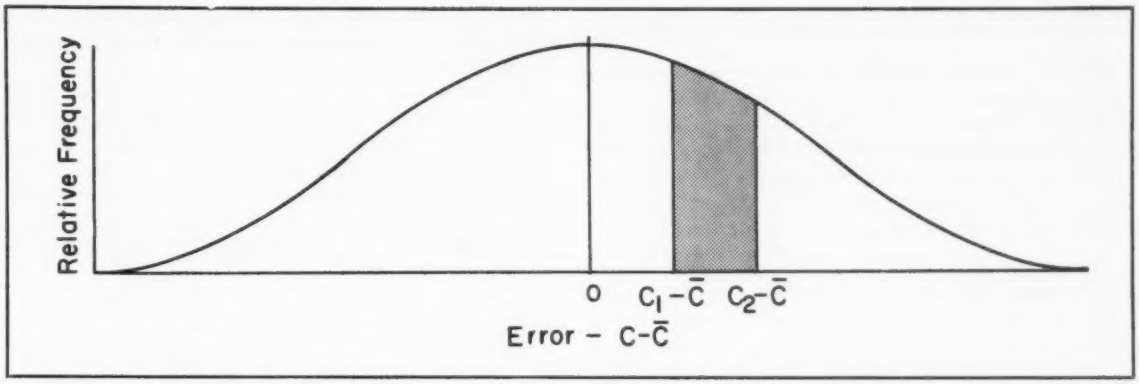

FIGURE 2—The shaded area represents the probability that any measured concentration is between C_1 and C_2.

How Good Is the Answer You Report?

Part 1—What are the Confidence Limits?

PART 2—How does it compare with others?

E. H. Wissler and R. S. Schechter
The University of Texas, Austin

HOW MANY times have you heard, "The concentration of impurity in this batch appears to be significantly different from previous batches?"

What was meant by this statement?

Obviously the statement implies that the concentrations of impurity in the previous batches were dispersed about some mean value and the difference between the particular batch in question and the mean of the previous batches is somewhat greater than expected. In a case such as this you can conclude that the difference is significant, take appropriate action, and accept the risk that it is not different. On the other hand, you can conclude that it is not significant, take no action, and accept the risk that it is different.

This article describes some simple statistical tools which are useful in making decisions based on somewhat imprecise data. Although it is impossible to remove the risk of making a wrong decision, it is possible to evaluate the probability of making a wrong decision. This probability, together with a knowledge of the consequences of making a correct or incorrect choice, can be valuable in making the decision.

The Basis. As an example assume that you routinely measure the concentration of an impurity in a sample drawn from each shipment of some raw material that you purchase. Since you have been doing this for some time, the statistical parameters are well established; that is, it has been established that the concentrations are distributed in some manner about the mean as illustrated in Figure 2. The distribution shown in Figure 2 is the normal or Gaussian distribution. All tests discussed in this paper are based on such a distribution.

In this figure, C is the concentration of impurity, $\bar{C}$ is the mean or expected concentration and σ is the standard deviation as determined for previously analyzed samples. The shaded area under the curve represents the probability that C for any sample is between C_1 and C_2. When the value of C_1 and C_2 fulfill the conditions:

$$\frac{C_1-\bar{C}}{\sigma}=-2$$

$$\frac{C_2-\bar{C}}{\sigma}=2,$$

the area under the curve between C_1 and C_2 is 0.95. In other words there is a 95 percent probability that any sample which belongs to the same population as the previously analyzed samples will lie between $\bar{C}-2\sigma$ and $\bar{C}+2\sigma$ and only a 5 percent probability that it will lie outside that range.

In using statistical tests, one first states a hypothesis and then evaluates the probability of the hypothesis being valid. Consider, for example, the case in which the measured concentration of impurity of a certain batch of material is 3.3 percent. The mean of the previous determinations is 2.7 percent and the standard deviation is 0.25 percent. Now hypothesize that the sample analyzed does come from a larger amount of material having a mean concentration of impurity $\bar{C}=2.7$ percent and that C does not equal $\bar{C}$ because of random errors in sampling and analysis. Choose a range of concentrations from C_1 to C_2 such that C will lie in that range with a certain probability, p, if the hypothesis is true. If C lies outside of the acceptance range, the hy-

pothesis is rejected and the probability of rejecting a valid hypothesis is 1 — p.

The acceptance range is often chosen so that p = 0.95. This tends to minimize the probability of rejecting a valid hypothesis or accepting an invalid hypothesis. For a normal distribution $C_1 = \overline{C} - 2\sigma$ or 2.2 percent and $C_2 = \overline{C} + 2\sigma$ or 3.2 percent.

For the simple problem being examined, the measured concentration 3.3 percent lies outside of the 95 percent range; we then reject the hypothesis and conclude that this batch of material is not from the same population as previously analyzed and some remedial action is indicated.

The "t" Test. In the preceding case the standard deviation had been established by the many analyses previously performed and the acceptance range for the test hypothesis was stated in terms of the normal distribution. Frequently one does not know the standard deviation of the population from which his samples are drawn. Then he must estimate the standard deviation using a limited number of data points, and he must define the acceptance limits in terms of the Student's t rather than in terms of normal distribution.

The Student's t which has been described in a previous article[3] is defined as follows:

$$t = \frac{|\bar{x} - u|}{s(\bar{x})} \qquad (1)$$

where

$\bar{x}$ = the mean of the observations

u = the expected value

$s(\bar{x})$ = the estimated value of the standard deviation of the mean.

The bars enclosing the difference $\bar{x} - u$ denotes that the absolute value; that is, the numerical value of t is always taken as being positive.

The value of $s(\bar{x})$ is given by

$$s(\bar{x}) = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n(n-1)}} = \sqrt{\frac{\sum_{i=1}^{n} (x_i)^2 - n\bar{x}^2}{n(n-1)}} \qquad (2)$$

TABLE 6—Impurity in Shipments

Sample No.	Weight %
1	3.8
2	2.6
3	2.8
4	3.3
Mean	3.1

TABLE 7—"t" at the 95% Confidence Level

Degrees of Freedom	t
1	12.7
2	4.30
3	3.18
4	2.78
5	2.57
6	2.45
8	2.31
12	2.18
24	2.06
∞	1.96

Note: Taken from information given in Reference 1.

where x_i is the value of the i^{th} of n observations. One of the important applications of the "t" test is illustrated by the following example.

The laboratory analysis of four samples drawn from a shipment of raw materials provides the data given in Table 6. The specification for this particular material claims an impurity concentration of 2.7 percent. Is the concentration of impurity in this shipment significantly greater than 2.7 percent or is the observed difference due to random error in the sampling and analytical procedure?

As before, the first step in the statistical test involves stating the test hypothesis. Hypothesize that the true mean concentration of the shipment from which the four samples were drawn is 2.7 percent. Go to Table 7 where you will find for the proper number of degrees of freedom the confidence interval within which 95 percent of the population lies if $\bar{x} = \mu$.

The number of degrees of freedom is essentially a measure of the reliability one can place in his estimated value of the standard deviation. Presume, for example, that a single measurement has been made. The computation of a standard deviation from a single measurement is impossible since no real measure of the degree of dispersion of the population is available. If two observations are made, a standard deviation can be computed as defined by Equation (2). This value of the standard deviation is based upon two observations which is just the minimum of information required to make the calculation. We then say that the number of degrees of freedom is one. Extending this reasoning we can see that in general the number of degrees of freedom in estimating the true standard deviation is equal to the number of observations minus one.

For the example being considered there are four observations and thus 3 degrees of freedom. The 95 percent confidence interval as read from Table 7 corresponding to 3 degrees of freedom is 3.18.

This value may be interpreted in the following way: If 20 sets of data, each set consisting of four samples, were drawn from the same population and all samples analyzed in the same way, then a value of t can be computed for each of the twenty sets. Of these 20 values of t only one would exceed 3.18 if the samples were drawn from the same population. In other words there is only 1 chance in 20 (5 percent chance) of observing a value of t greater than the critical or tabular value purely by chance.

In order to test the hypothesis that there is no difference between the specified concentration of impurity and the measured value other than chance error, we first compute the necessary statistical parameters using the information given in Table 6.

Thus by Equation (2)

$$s(\bar{x}) = \sqrt{\frac{[(3.8)^2 + (2.6)^2 + (2.8)^2 + (3.3)^2] - 4(3.1)^2}{4(4-1)}}$$

$$= 0.35 \text{ wt \%}$$

and by Equation (1)

$$t = \frac{|3.1 - 2.7|}{0.35} = 1.14$$

The calculated value of t, 1.14, is less than the critical value of 3.18; hence we accept the hypothesis as being true.

TABLE 8—τ at the 95% Confidence Level

Number of Observations	τ
2	6.35
3	1.30
4	0.72
5	0.51
6	0.40
7	0.33
8	0.29
9	0.26
10	0.23

Note: Abridged from a table presented in Reference 2.

It is important to remember that statistical methods are based on the laws of chance and certainly any conclusions should always be tempered by sound judgment. Also note that as the number of observations increases, the uncertainty in the standard deviation decreases, and the result becomes more reliable.

A Short-Cut Technique. In a previous discussion of the application of statistics to data reporting[3] the use of short-cut techniques was discussed. It was pointed out that short-cut techniques are useful because of the simplicity of the computations, and if only a few observations (2-10) are available, there is little loss in information.

An imitation t test based on the range has been defined[1] and although the statistic is less efficient than t, the computation is much easier and faster to perform.

The substitute t is defined as follows:

$$\tau = \frac{|\bar{x} - u|}{w} \qquad (3)$$

where

τ = the substitute t

w = the range, defined as the difference between the largest and the smallest observation.

Again hypothesize that the difference between the specified concentration of impurity and the measured value is due to random errors in the sampling and analytical procedure. As a test of this hypothesis, we can use τ rather than t. The computed value of τ is compared to the critical value and if the calculated value exceeds the critical value at some prescribed probability level, we reject the hypothesis. If the converse is true, we accept the hypothesis.

Table 8 gives the confidence interval on τ for the 95 percent confidence level as a function of the number of observations.

For four observations the critical value of τ at the 95 percent confidence level is 0.74. Based upon four observations there is only one chance in twenty of observing a value of τ greater than 0.74 purely by chance. Let us now obtain the value of τ based upon the data given in Table 6.

The range of the four measurements listed in Table 6 is

$$w = 3.8 - 2.8 = 1.2$$

and thus

$$\tau = \frac{|3.1 - 2.7|}{1.2} = 0.33$$

Since the calculated value of τ, 0.33, is less than the critical value corresponding to four observations we accept the hypothesis as being valid. This is the same result which was given by the t test.

Comparing Two Means. In the previous example the mean of a series of observations was compared to an expected value to evaluate the significance of the difference. There are cases, however, in which it is desirable to compare two means each of which is a result of small number of tests. Since the two means are dispersed around the true mean or means, one would logically ask the question, "Is the difference between the two means significant or is the observed difference due to chance errors?"

For example, two isomerization catalysts were tested in the same pilot plant reactor unit. The test results are given in Table 9. There is a difference in the yields produced by the two catalysts; however, if one views the individual results of each of the experiments, the dispersion of the results casts an element of doubt on the true significance of the difference between the two means.

Again statisticians have devised a test which will give information as to the probability of the two samples having been drawn from the same population. It must be re-emphasized, however, that statistics do not yield an absolutely black or white answer, but only a measure of probable truth.

To ascertain the significance of the difference in the yields produced by catalyst A and catalyst B, hypothesize that the two catalysts are equally effective. To test this hypothesis, the Student's t can be used provided the standard deviations of both tests are equal. The standard deviations can be considered as being equal for the results being compared since the tests were made using the same equipment, sampling procedure and analytical techniques. However, if there is some doubt regarding the validity of assuming equality of the standard deviations, one can determine if the two standard deviations are from the same population by using the F test. This test is discussed in a subsequent section.

The value of t used for comparing the two means is given by the following equation:

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\bar{s}(\bar{x})} \qquad (4)$$

Where

$\bar{x}_1$ and $\bar{x}_2$ = the two means being compared

$\bar{s}(\bar{x})$ = a "pooled" estimate of the population's standard deviation.

Since the standard deviations for both tests are equal, the test data for both catalysts are "pooled" or combined in estimating the standard deviation. This estimate of the standard deviation is defined as

$$s(\bar{x}) = \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)\left[\frac{\sum_{i=1}^{n_1} (\bar{x}_1 - x_1)^2 + \sum_{i=1}^{n_2} (\bar{x}_2 - x_i)^2}{n_1 + n_2 - 2}\right]} \qquad (5)$$

or

$$s(\bar{x}) = \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)\frac{(n_1 - 1)s^2_1 + (n_2 - 1)s^2_2}{n_1 + n_2 - 2}} \qquad (5a)$$

TABLE 9—Catalyst Effectiveness

	YIELD, WEIGHT, PERCENT	
Test Number	Catalyst A	Catalyst B
1	28.5	30.0
2	31.6	34.2
3	28.3	32.6
4	31.7	31.8
5	27.1	34.0
Mean	29.5	32.6

Where

n_1 and n_2 = the number of observations in test series 1 and 2, respectively and s_1 and s_2 = the standard deviations of groups 1 and 2 respectively.

$$s^2_1 = \frac{\sum_{i=1}^{n_1} (\bar{x}_1 - x_1)^2}{n_1 - 1} = \frac{14.24}{4} = 3.56$$

$$s^2_2 = \frac{\sum_{i=1}^{n_2} (\bar{x}_2 - x_1)^2}{n_2 - 1} = \frac{12.96}{4} = 3.24$$

and

$$\bar{s}(\bar{x}) = \sqrt{\left(\frac{1}{5} + \frac{1}{5}\right)\frac{(4)\ (3.56) + 4(3.24)}{5 + 5 - 2}} = 1.17 \text{ wt \%}$$

The value of t is

$$t = \frac{|32.6 - 29.5|}{1.17} = 2.74$$

Since there are two sets of observations associated with the estimate of the standard deviation, the number of degrees of freedom is the sum of the degrees of freedom associated with the evaluation of s_1 and s_2. In this case each of the individual values of s_1 and s_2 has 4 degrees of freedom and hence there are 8 degrees of freedom associated with the "pooled" estimate of the standard deviation. The critical value of t at the 95 percent confidence level is then the value associated with 8 degrees of freedom. From Table 7 this value is 2.31. Since the computed value of 2.74 is greater than the critical value, we reject the hypothesis and conclude that catalyst B is more effective than catalyst A.

Short-Cut for Comparing Means. A statistic τ_d[2] which is based on the range has been devised as a test of the significance in the difference between two means. This test is applicable if an equal and small number (10 or less) of observations are contained in each group.

Define τ_d as

$$\tau_d = \frac{|\bar{x}_1 - \bar{x}_2|}{w_1 + w_2} \qquad (6)$$

TABLE 10—τ_d at the 95% Confidence Level

Sample Size ($n_1 = n_2$)	Critical Value
2	1.71
3	0.636
4	0.406
5	0.306
6	0.250
7	0.213
8	0.186
9	0.167
10	0.152

TABLE 11—Variance Ratio for 95% Confidence Level

Degrees of Freedom $\phi_1 = \phi_2$	Ratio F
1	648
2	39.0
3	15.4
4	9.6
5	7.1
6	5.8
8	4.4
12	3.3
24	2.3

Where

$\bar{x}_1$ and $\bar{x}_2$ = the two means in question

w_1 and w_2 = the ranges of the two sets of observations.

The critical values for τ_d at the 95 percent confidence level are given in Table 10 for samples of equal size. In this case the critical value of τ_d at the 95 percent confidence level is 0.306 since $n_1 = n_2 = 5$.

The values of w_1 and w_2 for the isomerization tests are

$$w_1 = 31.7 - 27.1 = 4.6$$
$$w_2 = 34.2 - 30.0 = 4.2$$

Hence

$$\tau_d = \frac{|29.5 - 32.6|}{4.6 + 4.2} = 0.36.$$

Since this computed value of τ_d exceeds the 95 percent confidence interval, we reject the hypothesis. This is the same conclusion reached using the t test.

The F Test for Comparing Variances. As was pointed out in a previous section, the Student's t is useful in comparing means provided the standard deviation is the same for both groups of data. In the example considered we have assumed that this condition was fulfilled because the test data were obtained from the same test device. If, however, there is some question as to the validity of such an assumption, the F test can be used to test the significance of the difference between the two variances. (Note that the square of the standard deviation is called the variance in statistical terminology).

By definition

$$F = \frac{s^2_1}{s^2_2} \qquad s_1 > s_2 \qquad (7)$$

Where

s_1 and s_2 = the standard deviation being compared.

Note that the larger is divided by the smaller. As in the previous example the variance ratio F is used in the test of a hypothesis. In this case hypothesize that compare the calculated value of F to the critical value at the 95 percent confidence level which is given in Table 11 as a function of the number of degrees of freedom associated with the value of the standard deviation. The values given in Table 11 can be used only if the two standard deviations being compared are based on the same number of degrees of freedom, Φ. A more comprehensive table of critical variance ratios may be found in Reference 2.

The variance for the catalyst tests is

$$F = \frac{s^2_1(x)}{s^2_2(x)} = \frac{3.56}{3.24} = 1.10$$

This calculated value of F is less than the critical value of F corresponding to 4 degrees of freedom (number of observations minus one) given in Table 11. Hence we accept the null hypothesis as being valid.

The statistical tests demonstrated in this paper are well known standard methods which have long been employed by statisticians. The practical art of data analysis by applying these techniques can give savings of both time and money. Try them.

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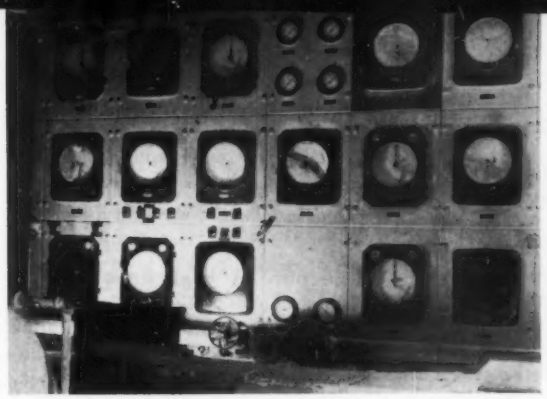

This control panel and five others were combined . . . to form this compact panel with miniature instruments.
FIGURE 1

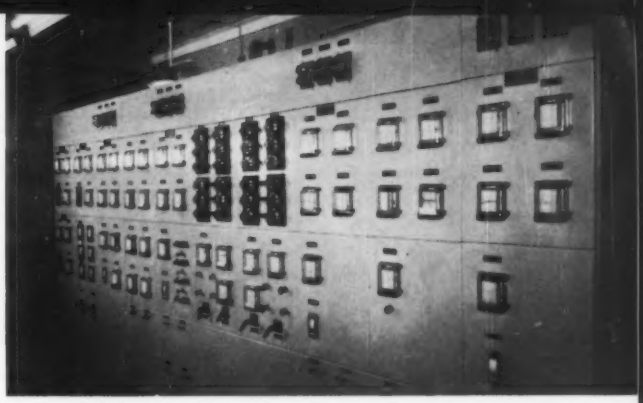

FIGURE 2

Instrumentation Engineering Cuts Maintenance Costs

For economy in instrument maintenance, follow these tips on design, specification and installation

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CONTRARY TO POPULAR opinion, the instrument department is *not* the place to start cutting maintenance costs. It is the instrumentation engineer, the man who designs the measurement and control systems and specifies the instruments to be purchased, who actually is most responsible for the ultimate economy in the maintenance of plant instrumentation. This is true even though he may have nothing to do with the selection and training of the personnel who actually operate and maintain the instruments or in the selection of the type of organization employed.

For many years the instrument companies have very wisely sought and received the opinions and recommendations of the experienced instrumentation engineers of the user companies. Many of us, particularly those who have had the benefits of plant instrument department experience, have made repeated trips into the factories of the manufacturers and have spent days with their research and design groups explaining our needs, examining the manufacturers' newest developments, and in general making available to them the knowledge acquired through years of varied experience. Most of the instruments, valves, and auxiliary devices being used today in some degree reflect the results of these consultations. The user companies can easily justify the expenses in both time and money involved in these trips through the assurance it gives of instruments better suited to their needs.

And today, maintenance in your plant is being benefited from much of this; for you have instruments that are better enclosed, instruments more easily kept clean both externally and internally, mechanisms that are sturdier and more easily calibrated, as well as more accessible, and assemblies that are better even down to such minor details as their requiring but a single type of screwdriver or a single size of wrench for adjustments, replacements, or overhaul.

Specifications. Another prepurchase influence that the instrumentation engineer has on instrument design, and subsequently on instrument maintenance, comes through the purchase specifications. These can be set up only by an instrumentation engineer. In his efforts to meet the performance specification, which should be a part of the purchase specifications, the manufacturer often refines his design or his manufacturing procedure and so produces a better instrument. This very thing has certainly given us improvements in accuracy, response rates, and general performance, and has also been a major factor in producing devices more resistant to environmental conditions, such as vibration, extreme temperatures, or corrosive atmospheres.

In particular, these user specifications, set up by engineers, were responsible for our long having had better motor valves, valves with properly sized springs, better stuffing boxes of low friction and long trouble-free life, and with integral stem and inner valve design and guided plugs made to very close tolerances. The use of tight specifications by some of the major users was instrumental in causing several valve manufacturers to set up standards and controls that produced better motor valves, valves that would function for 2, 3, 4, or perhaps 5 years between servicings.

Instrumentation Engineering Cuts Costs . . .

Easier Servicing. A look at the instruments that have been put on the market these last few years will reveal that, regardless of whether pneumatically or electrically actuated, provision has been made for the quick and easy change of the controlling or the recording mechanism. This has come about through a need recognized by the instrumentation engineers in both the instrument-using and the instrumet-manufacturing companies. Because of this, we can today employ the "telephone company type" of service to instruments wherein the field men need carry but few tools or perform but a few prefunctory tests to be followed, if neecssary, by the installation of new components rather than having to tear down and repair as has been past practice.

By its very nature, this type of procedure produces minimum disturbance to the operating unit. Perhaps most important today, though, is the fact that the field man need not necessarily be a highly trained, well-rounded, skilled technician. Further, rather than being subject to the hurried field repair, the removed parts can be given a thorough shop overhaul by skilled mechanics who are equipped with adequate auxiliary instruments. And if, for instance, it is desired to try a different mode of control—say, to add derivative—it can be done in but a minute's time with a minimum of the possibility of causing leaks, friction, incorrect action, or other time-consuming troubles.

Installation Standards. Every process industry surely uses installation standards for its various instrumentation items. Standards, carefully developed by the instrumentation engineers, will go far to assure that primary measurement elements are properly installed, that leads are properly sloped, that transmitters and exposed instrument items are properly housed, that case purges are used in zones of corrosive atmospheres, and that the thousand and one things needed to make instruments function properly are incorporated into the actual installation. They will see to it that motor valves are so installed that the valve positioner is accessible, that clearance is provided below the valve body so that the inner valve can be withdrawn without removal of the whole valve from the line, and that such obvious but easily overlooked items as spool pieces next to the valve flanges are provided to allow for bolt withdrawal. They will likewise tend to prevent valves and thermowells from being located in absolutely inaccessible places, as well as prevent the omission of connections and pressure gages at blind transmitters.

Selection of Instrumentation Items. They should, by all means, be selected by the instrumentation engineer and not by one who is unfamiliar with instruments and instrument usage. This selection, which is so important to low cost and efficient maintenance of instruments, should include several factors and should not be based on first cost alone. Remembering that both mechanics and supervisors of the plant instrument department must have knowledge and know-how about each type of device in the plant and that the storeroom must have parts for it, the engineer should think twice before putting the one, or several, of some odd variety of instruments in the plant "just for trial." The trial or testing of a device should be done in an evaluation laboratory or should be subject to a special installation in some existing or older plant where it can be subjected to test procedure rather than being treated as a permanent installation.

The engineer, in selecting instruments, should be sure that they have properties that will give satisfactory performance in their final environment. This may call for the instruments to have the ability to withstand vibration, to accurately measure or control while undergoing rapid changes in temperature (perhaps actual sprinkling with water or other liquids), and an occasional horizontal rain or dust storm. Motor valves need have this same careful consideration given to each individual item. The stem packing must be protected from extremes in temperature, and, of course, the packing material must be suited to the fluid, as should the sealing grease, if used.

The selection of the inner valve and seats, both in regard to material as well as design, should be made with shutoff, flow characteristics, erosion, and corrosion factors all in mind. Careful sizing of the valve is important, too, as it can influence its ultimate performance and life.

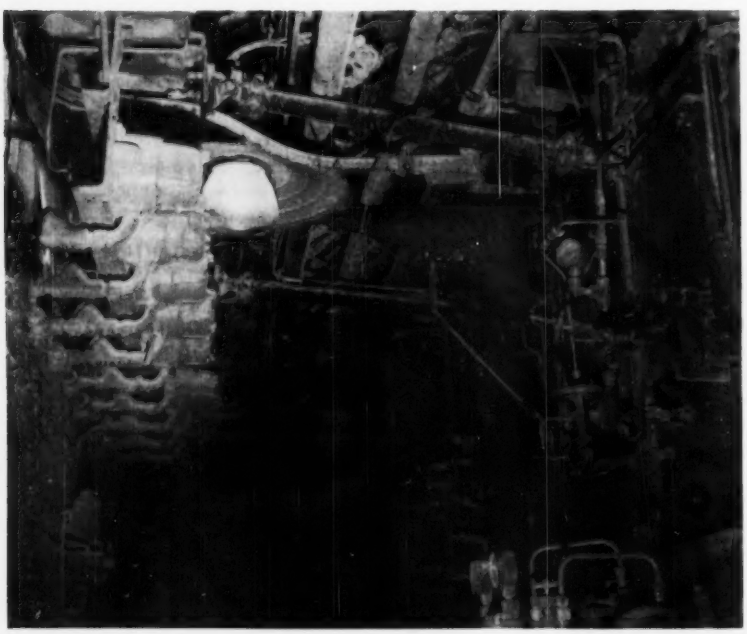

FIGURE 3—The clutter behind the old panel made maintenance costly.

Use Fewer Brands. The undesirability of using the new plant in-

strumentation as a testing laboratory for the untried instrument or valve can be expanded into showing the benefits of keeping the brands installed in any one plant to a reasonable minimum. Such a policy is unquestionably hard on the instrument manufacturer whose instrument you do not buy; nevertheless, from the maintenance point of view, it is a good policy. Minimum maintenance problems would be involved if but one brand of instrument and one brad of transmitter and one brand of motor valve were used throughout a plant, but unfortunately, or perhaps fortunately, this goal is seldom achieved. You will find, further, that you will occasionally be forced to depart from this policy by such factors as inability to obtain parts or an unfavorable change in the pricing or quality of parts, or the special cases where particular instruments fit in better than do the others. However, a reasonable compromise can normally be achieved here, but the maintenance problem should not be overlooked.

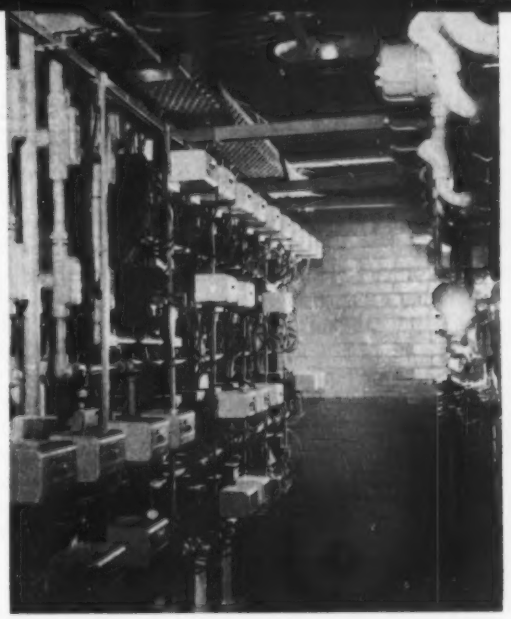

FIGURE 4—The orderliness behind the new panel encourages high grade craftsmanship and at one fourth the time required to maintain the old system.

Installation. No matter how good an instrument or valve may be, it is still quite possible for it to give poor performance and require much attention from the instrument mechanic. There have been many installations where performance was marginal simply because the installers were given insufficient information to do an intelligent job. The fault may lie in the location of the thermal bulb; again, it may be that the controller should have been mounted at the process rather than behind the control panel; perhaps the leads of a differential pressure instrument should have been installed with a purge; or it may be that this same device should have had one side close-connected to a vessel but, rather, was installed above, below, or some distance away from that vessel. Installation sketches, supplementing the installation standards by being made to fit the particular situation, will eliminate much of this type of trouble-making problem and, subsequently, will relieve the instrument department. These sketches should be drawn up at the time the engineer designs the measurement and/or control system and specifies the instruments so that their value may be properly utilized by the equipment, piping, and instrument layout men, as well as by the plant design draftsmen.

It is through the use of these installation sketches that the instrumentation engineer can convey to all persons concerned, his ideas. Here, he will show the use or non-use of gas purge, the relative position of the various elements involved, the dimensions of the connections for level or interface measurement, the location of thermal elements, the sampling point for analytical instruments, and the other vital details necessary for proper performance. They are the means of having an instrument system installed in the manner originally intended by the designing instrumentation engineer, and the time required to make them is paid for many times over by the aid that the sketches give the draftsmen, installing engineers, and others involved in getting the instrument ready for service. The greatest profit from their use is derived, however, by the istrument department which is responsible for the instrumentation once the unit or plant is started. All too often poor measurement and poor control are experienced for months or even years because of the difficulties, once operation has started, of changing improperly located connections, thermowells, transmitters, and valves.

Sampling Systems. Plant-type analytical instrumentation is becoming more common and more important each day. The instrumentation engineer who selects a device of this type should also make the sampling system a part of his work. As you know, the problems of proper sampling for plant-type analyzers have been subject to whole symposia and are surely worthy of special attention on his part. A poor sampling system is often responsible for unsatisfactory plant analyzer performance and, therefore, becomes another problem for the instrument department. The installation sketches that I have just talked about could prove adequate on some of the simpler installations, but, as you will observe from literature on this subject, the designs often become very involved, incorporating scrubbers, traps, heat exchangers, filters, dryers, and all sorts of regulators and seals. Regardless, the instrumentation engineer should accept as his responsibility the furnishing of a design for a proper sampling system. Often the analyzer manufacturer will be glad to cooperate—in fact, may be glad to furnish most of the design—knowing, as he does, the importance of good samples to the ultimate performance of his instrument. If the analyzer is part of a control loop, the sampling lag must be taken into full consideration in this design, or else the instrument department will be confronted with another time-consuming problem.

Control room design and layout, again an engineer's function, can materially affect instrument maintenance. Adequate and safe access

to the back of the control panels is required if the mechanic is to function properly. If the mechanic must crawl into a small, dark space, probably hot beyond all reason and dangerous because of poor exit facilities, he can hardly be expected to do a fast or a first-class job of adjustment or repair. The designing engineer must see to it that he has a reasonably decent environment in which to function.

This same consideration certainly holds for the console type of installation. I know of two specific cases in boiler houses where the mechanic reached the instruments by means of standing on a ladder from the floor below and working up through an opening in the operating room floor. Having no ventilation, this was an oppressively hot place where the mechanic soon became thoroughly soaked with his own perspiration. To add to the hazards, bare electrical connections carrying 120 volt alarm circuits were located on all sides, thereby exposing the mechanic's tools and even his head and body to shock. In the first place, no person should ever be asked to work under such dangerous and uncomfortable conditions, and, in the second, maintenance of such instrumentation can never be kept on the same plane as if it had been made properly accessible. In your efforts to achieve compactness and good appearance, don't forget that provision must be made for the comfortable servicing of all of the devices involved.

Engineering Report. The final step in achieving installations that will give the best chance of good performance with a minimum of care is that of giving the instrumentation engineer the opportunity of not only checking all blueprints drawn up on new plant design, but also of personally seeing the instrumentation during several stages of installation. Then, if within reason at all, he should have the opportunity of being present at start-up of the units so that he might observe the performance of the instrumentation he designed. This is all part of the feedback that we know is so essential if we would grow and improve in our methods.

A report of some sort, preferably a rather formal one, should be written by the engineer. Part of the information for this report will be based on the fact that the instruments were not installed as intended, and it is through this that improved procedures can be established to minimize this all too common trouble. Most of the information should come from the instrument department actually operating the measurement and control systems in the new installation, for it is they who will be most aware of the poor performance.

Alterations. Practically every point that has been covered will also apply to the alterations and small changes that continuously go on in existing operating plants. I have repeatedly witnessed, too, those cases where the plant instrumentation engineers have made economic studies and, after selling the operating unit heads, have proceeded to put in new instrumentation with the result that not only were the original economic aims achieved, such as increased production rates, improved product, or, as has so often been the case of late, coordination of operation of several units with a resultant decrease in operating labor requirements, but as a final dividend we found that instrument maintenance in the affected area was materially decreased.

For example, Figure 1 shows *one* of *five* control panels located in one of our process buildings. This picture was taken just before the panels were removed from service.

Figure 2 shows the control room designed for the use of miniature instruments in which one assembly takes the place of *all five* of the original panels. The benefits that accrued were several: better operation through better instruments, better coordination of operations, less operation labor, and, as a special dividend, a greatly reduced problem of instrument maintenance.

Figure 3 shows the back side of the original panel. Note that the overhead piping has become very cluttered over the years, that long leads were used to carry pressure to the manometers shown mounted on the panel board (right), and that safety devices and alarms had been stuck willy-nilly all over the place. This was typical of the panels involved in the economic study made to justify their replacement.

Figure 4 shows a rear view of the new panel. Here is an environment that permits the instrument mechanic to make accurate settings and calibrations, and its very orderliness and cleanliness encourage high grade craftsmanship. You don't see the transmitters involved, but these were properly installed and protected, and, with the elimination of the thermal and pressure leads formerly required, the need for constant zeroing and checking was greatly reduced. Actually, the maintenance time required by the new system was one-fourth of what it had been with the older systems. This, alone, represented almost 15 percent annual return on the new investment. Thus, again we have helped instrument maintenance through good instrumentation engineering.

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About the Author

Ralph D. Webb, associate director of engineering, Union Carbide Olefins Co., has been with Union Carbide Corp. since graduation from the University of Illinois with a B.S. degree in mechanical engineering, 1924. He has specialized in instrumentation engineering for 25 years and is now located at Carbide's Technical center, South Charleston, W. Va. He helped found the ISA and the Instruments and Regulators division of ASME. He is a member of ASME, AIChE, a Fellow in AAAS, and an honorary member of the ISA. He is a member of the Honors and Dynamic Systems committees of the IRD of ASME, and of the Admissions and Society Structure and Planning committees of ISA.

How to Design Tank Heating Coils

Now you can take the "art" out of tank heating coil design by using these experience-proved data

David Stuhlbarg
The Procter and Gamble Company, Cincinnati

DESIGN OF TANK HEATING COILS has remained more or less an "art." Here are formulas, backed up with experimental data, for calculating heat losses, coil area and a discussion of factors which affect coil layout and location.

Tank coil design falls naturally into two parts: thermal and physical. The former, in turn, sub-divides into determining the proper design basis, calculating the heat load on the coil, and finally, computing the coil area.

Physical design includes selecting size, computing length, deciding on type of coil and location in the tank, and then making the detailed layout.

DESIGN BASIS

Process requirements and properties of the stock determine in large part the selection of the proper design equations. It must be known whether the coil is expected to re-heat a cooled tank or merely maintain the hot tank temperature. If the stock does cool, will it partially solidify or "make-up," and if so, will it form a self-insulating layer on the top, bottom and sides?

Selection of the design case can usually be made from one of the following:

1. Steady state—internal coils
2. Steady state—external coils
3. Stocks cool—remain liquid
4. Stocks cool—form self-insulation
5. Stocks cool—solids settle
6. Stocks cool—re-heated with external coils

Each of these requires its own mathematical treatment, but all are based on assuming the ambient temperature (T_a) constant and using the average thermal properties of the stock.

Case I—Steady State—Internal Coils. This case is relatively simple; the load on the coil is the same as the heat loss by radiation and convection. It is only necessary to take into account the fact that different coefficients may apply to the top, bottom and sides. For tanks on legs,

$$q = (U_t A_t + U_b A_b + U_s A_s)(T - T_a) \qquad (1)$$

Equation (1) can be simplified in form by using the "equivalent area" concept. Let

$$A_e = \frac{U_t}{U_s} A_t + \frac{U_b}{U_s} A_b + A_s \qquad (2)$$

Then Equation (1) becomes:

$$q = U_s A_e (T - T_a) \qquad (3)$$

For an isothermal heating medium, the coil area is determined by:

$$A_c = \frac{q}{U_c (T_h - T)} \times \text{Safety Factor} \qquad (4)$$

For a non-isothermal heating medium, $(T_h - T)$ would be replaced by the log mean temperature difference.

Steady state requires less coil than any of the other cases, therefore, it is wise to make doubly sure that some other condition such as a week-end shutdown, storage without heat over a holiday, or even an emergency shutdown, does not more validly set the design basis.

Equation (3) applies also to flat bottom tanks, and to odd configurations such as tanks extending through the walls of buildings, etc., but the equivalent area will not be the same for these cases. McAdams[1] gives the heat loss from a thin disc buried in the ground as $q = (T - T_g)/R$. Where $R = \frac{1}{4\,Dk_g}$. If the heat loss from a flat bottom tank sitting on the ground is assumed to be one-half this value (since only one side is touching the ground), the heat loss

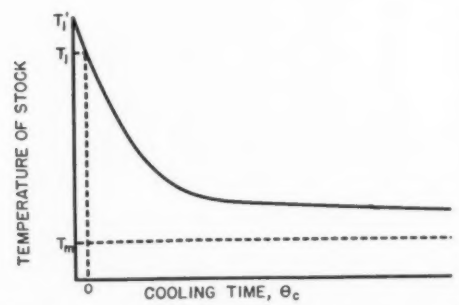

FIGURE 1—Is a typical cooling curve for Case IV when the cooled stocks form self-insulation.

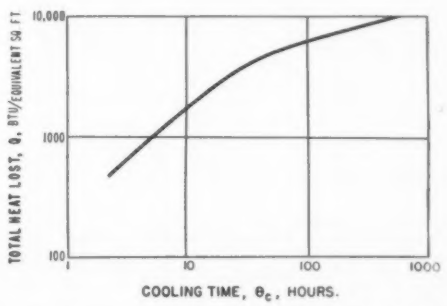

FIGURE 2—Shows typical heat losses for stocks forming self-insulation.

How to Design Tank Heating Coils . . .

from the tank would be:

$$q = (U_s A_s + U_t A_t)(T - T_a) + (2 D k_g)(T - T_g) \quad (5)$$

extracting U_s and $(T - T_a)$ as above, the equivalent area would become:

$$A_e = A_s + \left(\frac{U_t}{U_s}\right) A_t + \left(\frac{2 D_t k_g}{U_s}\right)\left(\frac{T - T_g}{T - T_a}\right) \quad (6)$$

The ground beneath the tank would probably be cooler (for an outdoor tank) near the periphery than at the center because of radial heat loss, therefore, T_g should be taken at some value between T_a and the true ground temperature. Similarly, for the tank extending through a building wall:

$$A_e = A_{e1} + \left(\frac{T - T'_a}{T - T_a}\right)\left(\frac{U'_s}{U_s}\right) A_{e2} \quad (7)$$

Where A_{e1} and A_{e2} are the equivalent areas for the two portions of the tank and T'_a and U'_s refer to A_{e2}.

The equivalent area concept will considerably simplify the more complicated cases which follow.

Case II—Steady State—External Coils. The problem is more complicated if external coils are required. These coils are usually attached to either the sides or the bottom (or both) and then covered with insulation. To design them thermally, it is convenient to assume that the heat flow is from the coil to the dead air space beneath the insulation. In order to replace radiation losses from the tank surfaces which are not protected by the coil (for example, the top, when the coil is on the sides and bottom), the dead air space must be at a higher temperature than the tank, and the heat balance—

$$(A_1)(T_d - T)(U_d) = (A_2)(T - T_a)(U_2) \quad (8)$$

applies. The heat load on the coil is:

$$q = (A_1)(T_d - T)(U_d) + (A_1)(T_d - T_a)(U_1) \quad (9)$$

$$\text{and } A_c = \frac{q}{(U_c)(T_h - T_d)} \times \text{Safety Factor} \quad (10)$$

where T_h is the average temperature of the heating medium.

In designing external coils, as much of the tank surface as possible should be traced. This will keep the temperature of the dead air space at a minimum, which in turn will minimize both the total heat loss and the coil area. This statement can be proven mathematically. From Equation (8):

$$T_d - T = \frac{A_2}{A_1} \times \frac{U_2}{U_d}(T - T_a)$$

The closer the ratio $\frac{A_2}{A_1}$ is to zero, the closer the temperature of the dead air space, T_d is to the tank temperature, T; the greater $(T_h - T_d)$ will be and, therefore, the smaller the coil area, A_c, will be.

Case III—Unsteady State—Stocks Remain Liquid. Frequently tanks are permitted to cool before heat is applied. To design coils for such tanks, it is necessary to determine the heat which has been lost in cooling. If the contents remain liquid, the problem is not difficult. Kern[2] has covered the heating and cooling of agitated batches by jacket or internal coils. If we assume his equations apply equally well to non-agitated tanks, we have for cooling:

$$\ln \frac{T_1 - T_a}{T_2 - T_a} = \frac{U_s A_e \theta_c}{MC_p} \quad (11)$$

from which T_2 can be calculated. The total heat lost in cooling is determined from:

$$Q = MC_p (T_1 - T_2) \quad (12)$$

An allowance should be made for radiation and convection losses during re-heating. If the average hourly loss during re-heating is assumed the same as during cooling, the required coil area is determined by:

$$A_c = \left(\frac{Q}{\theta_h} + \frac{Q}{\theta_c}\right)\left(\frac{1}{U_c \Delta T_m} \times \text{Safety Factor}\right) \quad (13)$$

A more rigorous equation is derived if the above assumption is not made. The following differential equation

TABLE 1—Heat Losses From Horizontal Bare Steel Pipes and Flat Surfaces[10]

In Btu Per Sq. Ft. of Pipe Surface Per Hour Per F. Temperature Difference Between Pipe and Air

PIPE SIZE INCHES	Lineal Foot Factor*	Temperature Difference F. Between Pipe Surface and Surrounding Air. Air at 80 F.											
		50	100	150	200	250	300	350	400	450	500	550	600
⅛	.220	2.12	2.48	2.80	3.10	3.42	3.74	4.07	4.47	4.86	5.28	5.72	6.19
¼	.275	2.08	2.43	2.74	3.04	3.35	3.67	4.00	4.40	4.79	5.21	5.65	6.12
1	.344	2.04	2.38	2.69	2.99	3.30	3.61	3.94	4.33	4.72	5.14	5.58	6.05
1¼	.435	2.00	2.34	2.64	2.93	3.24	3.55	3.88	4.27	4.66	5.07	5.51	5.97
1½	.497	1.98	2.31	2.61	2.90	3.20	3.52	3.84	4.23	4.62	5.03	5.47	5.93
2	.622	1.95	2.27	2.56	2.85	3.15	3.46	3.78	4.17	4.56	4.97	5.41	5.87
2½	.753	1.92	2.23	2.52	2.81	3.11	3.42	3.74	4.12	4.51	4.92	5.36	5.82
3	.916	1.89	2.20	2.49	2.77	3.07	3.37	3.69	4.08	4.46	4.87	5.31	5.77
3½	1.047	1.87	2.18	2.46	2.74	3.04	3.34	3.66	4.05	4.43	4.84	5.27	5.73
4	1.178	1.85	2.16	2.44	2.72	3.01	3.32	3.64	4.02	4.40	4.81	5.25	5.71
4½	1.309	1.84	2.14	2.42	2.70	2.99	3.30	3.61	4.00	4.38	4.79	5.22	5.68
5	1.456	1.83	2.13	2.40	2.68	2.97	3.28	3.59	3.97	4.35	4.76	5.20	5.65
6	1.734	1.80	2.10	2.37	2.65	2.94	3.24	3.55	3.94	4.32	4.72	5.16	5.61
Vertical Surface		1.84	2.14	2.42	2.70	3.00	3.30	3.62	4.00	4.38	4.79	5.22	5.68
Horizontal Surface, Facing Upward		2.03	2.37	2.67	2.97	3.28	3.59	3.92	4.31	4.70	5.12	5.56	6.02
Horizontal Surface, Facing Downward		1.61	1.86	2.11	2.36	2.64	2.93	3.23	3.60	3.97	4.37	4.80	5.25

Values are for Flat Surfaces four square feet or more in area.
* To secure losses per lineal foot, multiply sq. ft. losses in table by this factor. For larger pipe sizes and greater temperature differences, see references 9, 10.

applies:

$$\frac{dQ}{d\theta} = \frac{MC_p\,dT}{d\theta} = U_c A_c (T_h - T) - U_s A_e (T - T_a)$$

Expanding and rearranging

$$(U_c A_c T_h + U_s A_e T_a) - (U_c A_c + U_s A_e) T = MC_p \frac{dT}{d\theta}$$

Let $a = (U_c A_c T_h + U_s A_e T_a)$

$-b = (U_c A_c + U_s A_e)$

$$\int_o^{\theta_h} d\theta = MC_p \int_{T_2}^{T_1} \frac{dT}{a + bT}$$

$$\theta_h = \frac{MC_p}{b} \ln \left\{ \frac{a + bT_1}{a + bT_2} \right\} \qquad (14)$$

The writer has found that Equation (13) is sufficiently accurate for normal design work. Equation (14) is chiefly of academic interest with its principal use the evaluation of the error inherent in Equation (13).

Case III-A—Extended Storage—Stocks Remain Liquid. If the cooling time for Case III is quite extensive —several weeks or longer—the tank would be very little above the ambient temperature. For this case, the allowance in Equation (13) for radiation loss during re-heating is inadequate and the use of Equation (13) is not recommended. Equation (14) could be used, but it should be adequate to assume $T_2 = T_a$ and allow for radiation losses on the basis of an average tank temperature. Thus:

$$A_c = \left[\frac{Q}{\theta_h} + U_s A_e \left\{ \frac{T_1 + T_a}{2} - T_a \right\} \right] \left\{ \frac{\text{Safety Factor}}{U_c \Delta T_m} \right\} \qquad (15)$$

Case IV—Unsteady State—Stocks Form Self-Insulation. A much more complicated situation exists if stocks partially solidify during cooling. The actual heat loss will depend heavily upon the behavior of the made-up or solidified stock. If it sinks to the bottom, the loss would be greater than from fluids which do not make-up since the temperature difference is held high. If it forms a layer on the top, bottom, and sides, this serves as "self-insulation," which reduces subsequent heat loss and keeps the stock in the center in liquid form.

This latter case is analyzed mathematically in Appendix I. For the assumptions made, we find that

$$T_1 = T_m + \left(\frac{h_a}{K_i} (T_m - T_a) \right)^{.25} \qquad (16)$$

Where T_1 is the temperature at which solids just start to form and

$$K_i = .45\, k_f \left(\frac{\rho_f\, g \beta\, C_p}{\mu_f\, k_f} \right)^{0.25}$$

$$Q = MC_p (T_1 - T_i) + \left(\frac{\rho_m A_e\, k_m (T_m - T_a) \lambda}{K_i} \right) \left(\frac{1}{(T_1 - T_m)^{1.25}} - \frac{1}{(T_i - T_m)^{1.25}} \right) \qquad (17)$$

$$\theta_c = \frac{4MC_p}{K_i A_e} \left(\frac{1}{(T_i - T_m)^{.25}} - \frac{1}{(T_1 - T_m)^{.25}} \right) + \frac{\rho_m k_m \lambda (T_m - T_a)}{2 K_i^2} \left(\frac{1}{(T_i - T_m)^{2.5}} - \frac{1}{(T_1 - T_m)^{2.5}} \right) \qquad (18)$$

These equations simplify down to manageable proportions once the constants are inserted. It is necessary though to follow the assumptions made in the derivation, which means use constants for all terms except Q, T_1 and θ_c. The way to use the equations is:

1. Solve for T_1.
2. Insert T_1 and numerical constants for all terms except Q, T_1 and θ_c in Equations (13) and (14).
3. Assume a series of values for T_1 (greater than T_m), and solve for Q and θ_c. Graph T_1 vs θ_c and Q vs. θ_c (see Figures 1 and 2).
4. Determine T_2 and Q from the graphs.
5. Correct Q and θ_c for the difference between the initial tank temperature, T'_1 and T_1 as calculated from Equation (16) as follows:
   a. If $T'_1 > T_1$, add $MC_p (T'_1 - T_1)$ to Q

   $$\text{Add} \left[\frac{MC_p (T'_1 - T_1)}{U_s A_e \frac{T'_1 + T_1}{2} - T_a} \right] \text{ to } \theta_c$$

   b. If $T'_1 < T_1$, find θ_c for $T_c = T'_1$ on the graph, measure θ_c (corrected) from this point forward. Q (corrected) is the difference between Q for $T_1 = T_1$ and $T_1 = T'_1$.

   If T'_1 is close to T_1, these corrections would be small and can be safely omitted.
6. Find A_c from Equation (13).

Case V—Stocks Cool—Solids Settle. This case is somewhat easier to handle. If the cooling has progressed only to the point where some, but not all, of the stock has solidified, the heat loss would consist of two parts, Q_1, the sensible heat of the liquid, and Q_2, the latent heat of fusion of the solidified portion. Thus:

$$\text{Let } Q = Q_1 + Q_2 \qquad (19)$$

$$Q_1 = MC_p (T_1 - T_m) \qquad (20)$$

$$\theta_{c1} = \frac{Q_1}{U_s A_e \Delta T_m} \qquad (21)$$

$$\text{Where } \Delta T_m = \frac{T_1 - T_m}{\ln \frac{T_1 - T_a}{T_m - T_a}}$$

$$\theta_{c2} = \theta_c - \theta_{c1} \qquad (22)$$

$$Q_2 = U_s A_e (T_m - T_a)\, \theta_{c2} \qquad (23)$$

Q_2 cannot exceed $M\lambda$. If cooling beyond this point occurs, it will be as a solid.

If we again assume the average heat loss during re-heating is the same as during cooling, the coil area is approximated by

$$A_c = \left(\frac{1}{\theta_1} + \frac{1}{\theta_h} \right) \left(\frac{Q_1 \times \text{Saf. Factor}}{U_c \Delta T_m} \right) + \left(\frac{1}{\theta_2} + \frac{1}{\theta_h} \right) \left(\frac{Q_2 \times \text{Saf. Factor}}{U_c (T_h - T_m)} \right) \qquad (24)$$

$$\text{Where } \Delta T_m = \frac{T_1 - T_m}{\ln (T_h - T_m)/(T_h - T_1)}$$

Case VI—Stocks Cool—Reheated with External Coils. This case can be handled by an extension of Case II. Q is determined by Case III, IV or V, then the term Q/θ_h is added to the right hand side of Equation (8). Thus:

$$(A_i)\ (T_d - T)\ (U_d) = (A_2)\ (T - T_a)\ (U_2) + Q/\Theta_h \quad (25)$$

In this heat balance, T_d and T are actually both variable with time; but it should be adequate to use an average value for T and then solve for T_d. Equation (9) then modifies to:

$$q = A_1(T_d - T_a)\ (U_i) + A_2(T - T_a)\ (U_2) + Q/\Theta_h \quad (26)$$

and A_c may be found from Equation (10).

SAFETY FACTORS

The safety factors to be used in Equations (4), (10), (13) and (15) will be largely a matter of judgment, but the conservativeness of the design basis should be considered. For example, if Q is found by Case III-A, its value would be considered conservative. Likewise, if losses are based on full tanks in extreme weather, which is a condition which would arise extremely seldom, a large safety factor is unnecessary. However, the assumptions made in deriving Equations (17) and (18) are almost all liberal, hence a larger factor should be applied.

Also to be considered is whether the preset reheat time, Θ_h, does not already include a fair safety factor.

COEFFICIENTS

Methods for computing or determining coefficients for use in the foregoing equations are fairly well covered in the literature. For heat transmission from surfaces and through insulation, the writer has found Curve 3 and Table 1, taken from published bulletins,[10,11] quite useful.

For natural convection at vertical planes, McAdams[1] recommends the equation:

$$\frac{h_i L}{k_f} = 0.59\left[\frac{L^3 \rho_f^2\, g\, \beta \Delta t}{\mu_f^2} \cdot \frac{C_p\, \mu_f}{k_f}\right]^{0.25} \quad (27)$$

for values of L up to 3 feet and values of the bracketed term ranging from 10^4 to 10^9. For surfaces higher than 3 feet, h_i is independent of L, and Equation (27) reduces to the *dimensional* form:

$$h_i = .45\, k_f\left[\frac{\rho_f^2\, g\, \beta\, C_p\, \Delta T}{\mu_f\, k_f}\right]^{0.25} \quad (27a)$$

In agitated tanks, the value of h_i would be sufficiently high so that the resistance $1/h_i$ would be negligible; however, for design Cases III through VI, the agitator would normally be turned off during a week-end or shut down period, hence Equation (27) or (27a) would apply.

The over-all heat loss coefficient, U_s, for the sides of tanks would be:

$$U_s = \left[\frac{1}{h_a} + \frac{1}{h_i} + \frac{1}{h_{ins}} + r_m + r_f\right]^{-1} \quad (28)$$

where h_a is based on Curve III for outdoors or taken from Table 1 for indoors. Normally, the resistance of the tank wall, r_m, is negligible. For a bare tank, of course, the term $1/h_{ins}$ drops out.

For a tank on legs, the bottom coefficient, U_b, may be taken conservatively the same as U_s.

For a flat bottom tank sitting on the ground, the use of equivalent area found from Equation (6) is recommended.

The top coefficient, U_t, is affected by the resistance of the confined air space, hence:

$$U_t = \left[\frac{1}{h_a} + \frac{1}{h_a'} + \frac{1}{h_a''} + \frac{1}{h_{ins}} + r_m\right]^{-1} \quad (29)$$

where h_a' and h_a'' are taken from Table 1.

There is one exception to the use of Equation (29). If the tank contents are at or near boiling, h_a' and h_a'' are increased considerably by evaporation and condensation. In this case, the only safe procedure is to assume the confined air space has negligible resistance, thus:

$$U_t = \left[\frac{1}{h_a} + \frac{1}{h_{ins}} + r_m\right]^{-1} \quad (29a)$$

Heat transfer to and from the confined air space at external coils can be safely based on values taken from Table 1. Thus:

$$U_d = \left[\frac{1}{h_a'} + \frac{1}{h_i} + r_m + r_f\right]^{-1} \quad (30)$$

TABLE 2—Coefficients

Coefficient	Application	Value		Basis
h_a	Outdoor Tanks	5.9		Fig. 3 for 15 fps (10.2 mph) wind at 100 F. ΔT.
	Indoor Tanks	1.84		Table 1 for still air at 50 F. ΔT at vertical surfaces. To further simplify this figures may be used for all surfaces.
h_a', h_a''	Confined Air Space	1.84		
h_i	Oil-Outdoors	10		Equation (27) for 100 F. ΔT and oil with the following properties: $C_p = 0.5$; $\mu_f' = 40$ cps; $k_f = .09$; $\beta = .000416$
	Oil-Indoors	8.4		Same, except $\Delta T = 50$ F.
	Water	36.5		Equation (27) for 50 F. ΔT and film temperature of 100 F.
h_{ins}	1" tk Insulation	.468		85 percent magnesia insulation, k = 0.039 BTU/(hr.) (sq. ft.) (F./ft.)
	2" tk Insulation	.234		
	3" tk Insulation	.156		
h_o	Oil	20		Equation (33) for 200 F. ΔT, 2 inch standard pipe and same oil as above except $\mu_f' = 20$ cps.
	Water	200		Chilton, et al nomograph as modified by McAdams for Perry's Handbook. Water at 150 F. film temperature at 2 inch standard pipe.
		Bare	Insulated 1 Inch	
U_s	Oil Tanks-Outdoors	3.7	.415	Equation (28) with r_m and r_f assumed negligible and above values for h_a, h_i, and h_{ins}.
	Water Tanks-Outdoors	5.1	.43	
	Oil Tanks-Indoors	1.5	.36	
	Water Tanks-Indoors	1.8	.37	
U_t	Outdoors	.8	.29	Equation (29) with values of h_a, h_a', h_a'', h_{ins} from above, r_m negligible.
	Indoors	.63	.27	Equation (29) with $h_a = 2.03$ from Table 1 and other values as above.
U_b	Tanks on legs	Same as U_s		Conservative assumption.
	Flat Bottom Tanks on ground	Not applicable		See Table 3 for A_e.
U_o	Oil-Steam	20		Assumed same as h_o.
	Water-Steam	120		Equation (36) with $h_i = 1300$, $r_m = .00053$ and $r_f = .002$.
U_d	Oil	1.55		Equation (30) with $h'_a = 1.84$, $h_i = 10.0$ and r_m and r_f negligible.
	Water	1.76		Equation (30) with $h'_a = 1.84$, $h_i = 46$, r_m and r_f negligible.
K_g	Flat Bottom Tanks	.8		Rough average of conductivities of clay and loam determined by University of Minnesota, Engineering Experimental Station.

TABLE 3—Equivalent Areas* for Vertical Cylindrical Tanks

APPLICATION	Fluid	U_e	A_e
Tanks On Legs-Outdoors-Not Insulated	Oil	3.7	$.22\ A_t + A_b + A_s$
	Water at 150 F.	5.1	$.16\ A_t + A_b + A_s$
Tanks On Legs-Outdoors-Insulated 1 inch	Oil	.45	$.7\ A_t + A_b + A_s$
	Water	.43	$.67\ A_t + A_b + A_s$
Tanks On Legs-Indoors-Not Insulated	Oil	1.5	$.53\ A_t + A_b + A_s$
	Water	1.8	$.35\ A_t + A_b + A_s$
Tanks On Legs-Indoors-Insulated 1 inch	Oil	.36	$.8\ A_t + A_b + A_s$
	Water	.37	$.73\ A_t + A_b + A_s$
Flat Bottom Tanks**-Outdoors-Not Insulated	Oil	3.7	$.22\ A_t + A_s + .43\ D_t$
	Water	5.1	$.16\ A_t + A_s + .31\ D_t$
Flat Bottom Tanks**-Outdoors-Insulated 1 inch	Oil	.36	$.7\ A_t + A_s + 3.9\ D_t$
	Water	.37	$.16\ A_t + A_s + 3.7\ D_t$
Flat Bottom Tanks-Indoors-Not Insulated	Oil	1.5	$.53\ A_t + A_s + 1.1\ D_t$
	Water	1.8	$.35\ A_t + A_s + .9\ D_t$
Flat Bottom Tanks-Indoors-Insulated 1 inch	Oil	.36	$.8\ A_t + A_s + 4.4\ D_t$
	Water	.37	$.73\ A_t + A_s + 4.5\ D_t$

* Based on coefficients from Table 2.
** The ratio $(T-T_a)/(T-T_s)$ assumed at .85 for Outdoor Tanks.

$$U_i = \left[\frac{1}{h_a'} + \frac{1}{h_{ins}} + \frac{1}{h_a}\right]^{-1} \quad (31)$$

$$U_e = \left[\frac{1}{h'_a} + \frac{1}{h_h} + r_m + r_f\right]^{-1} \quad (32)$$

Where h_a' is the value for flat surface or pipe, as appropriate.

Coil coefficients for natural convection can be most conveniently found from a nomograph prepared by Chilton, Colburn, Generaux and Vernon[13] which is based on the equation

$$\frac{h_c D_o}{k_f} = 0.47 \left[\frac{D^3{}_o \rho_f \beta g \Delta t}{\mu_f{}^2} \cdot \frac{C_p \mu_f}{k_f}\right]^{0.25} \quad (33)$$

This nomograph has been republished in a number of references including McAdams[1] and Kern.[2] McAdams recommends, for single horizontal cylinders, values 10 percent higher than those found by the nomograph or Equation (33). For banks of tubes, Kern recommends use of these values without correction. A modified version of the nomograph which includes the McAdams correction is published in Perry's Handbook.[14]

For natural convection at vertical tubes, the coefficient may be taken the same as at vertical planes as determined by Equations (27) or (27a).

For tanks agitated with top entering turbines and using vertical tubes as baffles, Dunlap and Rushton[7] found that:

$$\frac{h_c D_o}{k} = .09 \left(\frac{D_b}{D_t}\right)^{.33} \left(\frac{2}{B}\right)^{0.2} \left(\frac{\mu}{\mu_f}\right)^{0.4} \left(\frac{C_p \mu}{k}\right)^{0.3} \left(\frac{D_b{}^2 N \rho}{\mu}\right)^{0.65} \quad (34)$$

For helical coils in a baffled tank agitated by a top entering agitator, Oldshue and Gretton[3] found that:

$$\frac{h_c D_o}{k} = .17 \left(\frac{D_b{}^2 N \rho}{\mu}\right)^{0.67} \left(\frac{C_p \mu}{k}\right)^{0.37} \left(\frac{D_b}{D_t}\right)^{0.1} \left(\frac{D_o}{D_t}\right)^{0.5} \quad (35)$$

Coefficients for many other mixing configurations are covered in the literature.[4, 5, 6, 8]

The test data reported in Table 4 are for a spiral coil in a tank agitated with a side entering propeller agitator. So far as the writer has been able to determine, no general equation has been developed for this case. A coefficient calculated for the conditions of the test using Equation (35) was 25 percent higher than the test coefficient. Until such time as more experimental data is available and a more precise equation developed, it is suggested that the Oldshue and Gretton equation be used for coils in tanks with side entering agitators with a correction factor of 0.80.

For low values of h_c, the over-all coil coefficient will be a little different from h_c and may often be assumed the same. For the general case:

$$U_c = [1/h_c + 1/h_i + r_m + r_f]^{-1} \quad (36)$$

where h_i is the tubeside coefficient referred to the outside.

SIMPLIFIED PROCEDURES

To expedite design work, it is possible to calculate heat loss coefficients for common fluids and selected weather conditions, set these up in a table, and use them for many widely different conditions. Some loss of accuracy will ensue; but if care is taken in the application, or if corrections are made for deviations from the design constants used in setting up the table, the error should be negligible.

Similarly, coil coefficients can be predetermined for the same fluids for a standardized coil size and selected heating media and set in table form for reference. Using the heat loss coefficients, simplified equations for the equivalent area for common tank designs can also be developed in advance, and these, too, will simplify calculations.

This technique is illustrated by Tables 2 and 3 which have been set up for two fluids, water and edible oil in vertical cylindrical tanks for the "standardized" conditions given in the last column of Table 2.

Similar tables can be set for other fluids; or time can be saved by modifying the coefficients given in Table 2 to other fluids or conditions. For example, for an oil with a film viscosity of 5 cps.,

$$h_i \text{ (outdoor tank)} = \left(\frac{40 \text{ cps}}{5 \text{ cps}}\right)^{0.25} \times 10 = 16.8$$

Similarly, for a conductivity of 0.08 instead of 0.09,

$$h_i = \left(\frac{.08}{.09}\right)^{.75} \times 10 = 9.16$$

Similar corrections can be applied for temperature difference, thermal expansion, etc. It should be noted, however, that ΔT in Equations (27) and (27a) is the difference across the film only and not $(T - T_a)$.

Another shortcut is to assume the area of a shallow cone or dished head to be 20 percent greater than a flat head with the same diameter, e.i.:

$$A_t \text{ (or } A_b) = 1.20\ (\pi/4)\ D_t{}^2 \quad (37)$$

How to Design Tank Heating Coils . . .

A horizontal cylindrical tank can be handled by treating area in contact with the fluid as A_s (coefficient—U_s) and all area above the liquid level as A_t (coefficient—U_t).

PHYSICAL DESIGN

Once the amount of coil needed has been determined, the other factors affecting coil design, such as size, location, and configuration must be resolved. Material selection for corrosion resistance is also important, but it is outside the scope of this article.

Cost considerations usually determine the size pipe used. If the coils are shop fabricated, 2-inch and 2½-inch are reportedly the most economical sizes, with little difference in price when compared on a surface square foot basis; but if the coils are field fabricated, the writer has received reports which favor either 2-inch or 1½-inch. As a result, and since the designer rarely knows in advance whether a coil is to be field or shop fabricated, standardizing designs at 2″ is recommended unless some other factor modifies the choice. For example, if water is the heating medium, it may be necessary to reduce the size in order to secure a satisfactory waterside heat transfer coefficient.

Plate coils and finned tube tank heaters are used at times in lieu of bare pipe and have some advantages. Plate coils are easy to clean, and finned tube heaters offer considerable heat transfer area in a compact bundle that can be brought into a tank through a 20 inch manhole.

Tank suction heaters are also used occasionally instead of coils. Their function is somewhat different in that they heat only the stream being pumped off rather than the entire tank contents. They are applied particularly to very viscous liquids which are difficult to pump when cold. They are designed and built much like exchangers and may be of either shell and tube or finned tube construction. They differ in that they are mounted through the wall of the tank and the end of the shell is left open to serve as a stock inlet.

The advantages of suction heaters are: they save on fuel costs since tanks are left cold, and there is no time required for reheating the tank before using the stock. The disadvantages are: their applications are limited, and the tank cannot be pumped completely empty through the heater.

A number of problems on coil configuration and location have been investigated.

In one test, it was discovered that, for stocks which partially freeze, complete coverage of the tank bottom is important. A tank containing tallow, which normally melts completely around 100 F., was observed during reheating after three months storage in moderate weather. It was noted that by the time the tank reached 120 F., most of the tank wall had become warm to the touch, indicating the stock inside had remelted; but two areas, 3 to 4 feet wide and extending up from the ground about 5 feet, remained cold for considerably longer. These were not completely warmed until the bulk of the stock had been seriously overheated. The tank was later drained and entered and it was found that the coil was of 2-inch pipe set on 24-inch centers well distributed across the bottom, except at the two areas which were last to be heated. These areas had a small amount of unmelted tallow left near the wall. There were also a few spots halfway between successive turns of the

TABLE 4—Test Data: Effect of Coil Height On Coefficient

TANK NO.	Coil Height	STOCK Height, Inches	STOCK Temp. F.	STEAM Flow #/hr.	STEAM Pressure, psi Inlet	STEAM Pressure, psi Outlet	STEAM Heat Content, BTU/# Inlet h_g	STEAM Heat Content, BTU/# Outlet h_f	h_g-h_f BTU/#	Heat Transferred BTU/hr.	LMTD* F.	Coefficient BTU/(hr) (sq. ft.) (F.)
Without Agitation												
118	½ Inch	225.5	112.5	1995	122	104	1192.6	311.7	880.9	1,759,000	233.5	37
			113	2020	120.5	104	1192.9	311.7	881.2	1,780,000	232.5	37.6
			114	2080	123	106	1193.3	313.0	880.3	1,830,000	232.4	38.7
			115	2070	126	108	1193.5	314.3	879.2	1,820,000	233.3	38.4
												Avg. 37.9
119	0	148.5	115	2055	121	108	1192.9	314.3	878.6	1,800,000	231.9	38.2
			116	2110	124	112	1193.3	316.9	876.4	1,850,000	233.0	39.0
			117	2110	124	112	1193.3	316.9	876.4	1,850,000	233.0	39.0
												Avg. 38.7
With Agitation												
118	½ inch	226.0	122	2330	68	37	1193.1	253.7	939.4	2,185,000	178	60.4
			122	2340	68.5	37	1193.2	253.7	939.5	2,200,000	177	61
			122.5	2105	58	30	1193.6	243.3	950.2	2,000,000	168.2	58.5
			123	2100	57.5	28	1193.7	240.4	953.3	2,000,000	162.5	60.5
			123	2095	58	28	1193.6	240.4	953.2	1,995,000	166.5	59
			123	1832	43	12	1193.8	212.7	981.1	1,800,000	143.5	61.6
			123.5	1832	42	11	1193.8	210.5	983.3	1,800,000	140.5	63.2
			124	1848	41	10	1193.8	208.3	985.5	1,820,000	138.5	64.7
			124	1720	36	7.0	1194.0	201.3	992.7	1,710,000	132.2	64.5
			124	1720	36	6.0	1194.0	198.7	995.3	1,710,000	130.2	69.5
												Avg. 62.3
119	0	149.0	122	2160	54	22	1193.4	231	962.4	1,800,000	160	64
			123	2190	51	14	1193.5	216.8	976.7	2,140,000	150	70.1
			124	2245	53	16	1193.4	220.6	972.8	2,185,000	151.8	71
			125	2325	61	20	1193.0	227.8	965.2	2,245,000	159.3	69.4
			125.5	1590	31	10.5	1193.8	209.4	984.4	1,562,000	134.0	57.3
			126	1580	29	1.0	1193.8	184.3	1009.5	1,591,000	116.4	67.3
			127	1980	45	11	1193.2	210.5	982.7	1,945,000	138.6	69
			127.5	1945	46	14	1193.2	216.8	976.4	1,900,000	142.1	65.7
			128	1980	46	14	1193.2	216.8	976.4	1,935,000	142.5	66.8
												Avg. 66.7

* Based on the assumption that steam entered coil at the saturated temperature.

coil which retained a small amount of unmelted tallow. Subsequent discussions with factory personnel led the writer to believe that this behavior was typical for fat storage tanks. To alleviate the condition, a standard design was set up for this type of material calling for an encircling coil ring within 6 inches of the tank wall, and sufficient bottom coverage so that no point on the bottom would be more than 12 inches from the coil.

The height of coils above the bottom has been given some attention. A survey of Procter & Gamble factories disclosed that coil heights up to 14-inches have been used; but that partially frozen stocks could not be remelted more than 6-inches to 8-inches below the coil. In one case, it was found that a particular stock melting at 180 F. could not be remelted more than 2-inches below the coil. Some factories expressed a preference for coils set directly on the bottom to facilitate the re-melt; whereas others preferred coils set 6-inches high to minimize clean-out time. Where coils are set directly on the bottom, they are raised temporarily on blocks to permit cleaning the bottom with squeegees.

The present standardized design permits coils either on the bottom or supported 6-inches high, depending on the stock, shape of the tank, and factory preference.

The above applies principally to tanks without agitators. There is apparently satisfactory remelting in agitated vessels regardless of coil height.

To determine whether setting coils directly on the bottom impeded heat transfer, tests were run on two identical new tanks. In one, the coil rested on the bottom. In the other, it was raised about 2-inches on blocks. The tanks were equipped with side entering agitators and data was taken with these both on and off. Unfortunately, circumstances did not permit running the tests with the same amount of liquid in both tanks, but the results, given in Table 4, still indicated that there was no appreciable difference in heat transfer between the two.

If the coil is very long, it may be necessary to split it into two or more branches to avoid an excessive pressure drop. With steam as the heating medium, Dunn and Stuhlbarg[15] found the pressure drop of condensing steam followed the modified Fanning Equation—

$$F = \frac{1}{3} \times \frac{2f\,LV^2}{gD} \qquad (38)$$

where V is computed for steam at the coil inlet.

APPENDIX I

Derivation of Heat Loss Equations for Batch Cooling with Self-Insulation

In considering this case mathematically, make the following assumptions:

1. The ambient temperature is constant.
2. Coefficient of heat loss to the air, h_a, is constant.
3. Resistance of the tank wall is negligible.
4. The equivalent area concept applies and makes all necessary corrections for variations in coefficient and external temperature.
5. The physical properties of the stock, both liquid and solid, are constant over the cooling range, and further, that the specific heat is the same for both liquid and solid.
6. The stock has a fixed freezing point, T_m, and does not subcool beyond this point as a liquid, and all frozen stock is part of the solid crust.
7. The liquid phase is at a uniform temperature, T_l.
8. Equation (27a) applies to the liquid phase of the tank contents. We will use this equation in the abbreviated form—

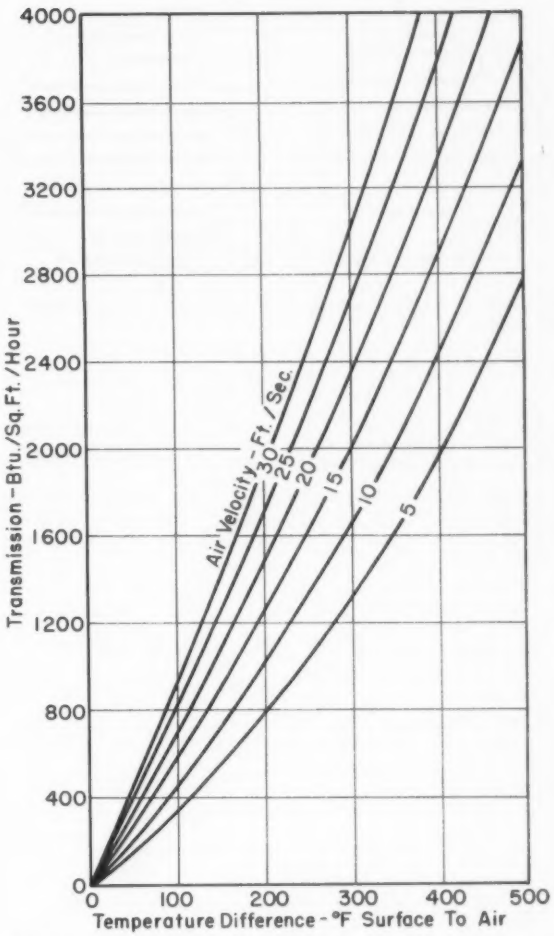

FIGURE 3—Various wind velocities affect heat transmission from large flat surfaces in this manner.[16]

$$h_l = K_l\,(T_l - T_m)^{0.25}$$

$$\text{where} \quad K_l = .45\,k_f \left(\frac{\rho_f^2\, g\, \beta C_p}{\mu_f\, k_f} \right)^{0.25}$$

At any given time, Θ, the heat balance is

$$q = h_a A_e\,(T_w - T_a) = h_m A_e\,(T_m - T_w) = h_l A_e\,(T_l - T_m)$$

Assume that at $\Theta = 0$, solid stock is just starting to form, therefore T_w must equal T_m, and T_l is at a fixed temperature T_l. Thus

$$h_a\,(T_m - T_a) = h_l\,(T_l - T_m)$$

Substituting for h_l

$$h_a\,(T_m - T_a) = K_l\,(T_l - T_m)^{1.25}$$

Solving:

$$T_l = T_m + \left[\left(\frac{h_a}{K_l} \right) (T_m - T_a) \right]^{0.8} \qquad (16)$$

The following relationships are derived from the heat balance:

$$q = K_l A_e\,(T_l - T_m)^{1.25}$$

$$T_w = T_a + \frac{K_l}{h_a}\,(T_l - T_m)^{1.25}$$

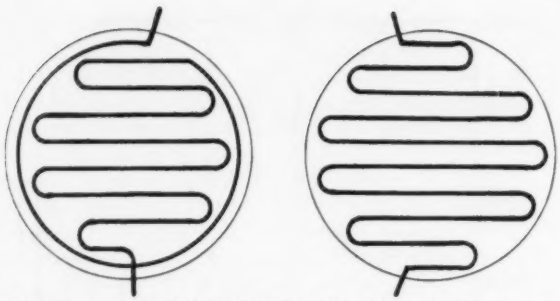

FIGURE 4—Typical hairpin tank coils with encircling ring on the right.

$$l' = \left(\frac{k_m}{h_m}\right) = \left(\frac{k_m}{K_i}\right)\frac{(T_m - T_a)}{(T_i - T_m)^{1.25}} - \frac{k_m}{h_a}$$

Let dQ be heat lost in time dΘ. dQ is the sum of sensible heat loss of liquid, sensible heat loss of solidified stock, and heat of fusion of stock solidifying, all in time dΘ.

Assume total sensible heat is $MC_p\,(-dT_i)$ (error due to variation in specific heats and sub-cooling of crust will be small for thin layers and can be safely neglected.) The heat of fusion is $\lambda\,\rho_m\,A_e\,dl'$.

$$dQ = MC_p\,(-dT_i) + \lambda\rho_m\,A_e\,dl'$$

$$Q = MC_p\int_{T_1}^{T_i}(-dT_i) + \lambda\rho_m\,A_e\int_{T_1}^{T_i} dl'$$

$$dl' = d\left[\frac{k_m\,(T_m - T_a)}{K_i(T_i - T_m)^{1.25}} - \frac{k_m}{h_a}\right] = \frac{(-1.25)\,k_m(T_m - T_a)\,dT_i}{K_i(T_i - T_m)^{2.25}}$$

$$Q = MC_p\,(T_1 - T_i) + \left[\frac{\lambda\rho_m\,A_e\,k_m\,(T_m - T_a)}{K_i}\right]\left[\frac{1}{(T_i - T_m)^{1.25}} - \frac{1}{(T_1 - T_m)^{1.25}}\right] \qquad (17)$$

$$\text{Also}\quad d\theta = \frac{dQ}{q} = \frac{MC_p(-dT_i)}{K_i A_e(T_i - T_m)^{1.25}} + \frac{\lambda\rho_m\,A_e\,dl'}{K_i A_e(T_i - T_m)^{1.25}}$$

$$\theta = \frac{MC_p}{K_i\,A_e}\int_{T_1}^{T_i}\frac{(-dT_i)}{(T_i - T_m)^{1.25}} + \left[\frac{\lambda\rho_m\,k_m(T_m - T_a)}{K_i^{\,2}}\right]\int_{T_1}^{T_i}\frac{(-1.25)\,dT_i}{(T_i - T_m)^{3.5}}$$

$$\theta = \frac{4\,MC_p}{K_i\,A_e}\left[\frac{1}{(T_i - T_m)^{.25}} - \frac{1}{(T_1 - T_m)^{.25}}\right] + \frac{\lambda\rho_m\,k_m(T_m - T_a)}{2\,K_i^{\,2}}\left[\frac{1}{(T_i - T_m)^{2.5}} - \frac{1}{(T_1 - T_m)^{2.5}}\right] \qquad (18)$$

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NOMENCLATURE

- A — area, sq. ft.; A_b—of tank bottom, A_c—of coil, A_e—equivalent, A_s—of sides, A_t—of top, A_1—equivalent area receiving heat from external coils, A_2—equivalent area not covered with external coils, A_{e1}—area below liquid level, A_{e2}—area above liquid level.
- A_x — cross sectional area, normal to fluid flow, sq. ft.
- a, b — constants used in Case III.
- B — number of baffles in an agitated tank.
- C_p — specific heat, Btu/(hr.)(F.).
- D — diameter, ft.; D_b—of blade, D_o—of pipe or tubing used for coil, D_t—of tank.
- F — pressure drop, feet of liquid.
- f — friction factor, dimensionless. Generally taken at .012 for condensing steam.
- g — acceleration due to gravity, 4.17×10^8 ft./hr.^{2}.
- h — film coefficient or conductivity, Btu/(hr.)(sq. ft.)(F.); h_a—of ambient air, h'_a, h''_a—of enclosed or confined air, h_c—of coil, h_h—of heating medium, h_i—of liquid phase of tank contents, or tubeside coefficient referred to outside of coil, h_{ins}—of insulation, h_m—of solidified stock.
- K_i — constant—(see Case IV).
- k — thermal conductivity, Btu/(hr.) (sq. ft.) (F./ft.); k_f—at average film temperature, k_g—of ground below tank, k_i—of liquid in tank, k_m—of made-up or solidified stock.
- L — height of tank wall, ft., or length of coil, ft.; L_{ins}—thickness of insulation, ft.
- l' — thickness of made-up layer of stock, ft.
- M — weight of tank contents, when full, lbs.
- m — weight of made-up layer of stock, lbs.
- N — agitator speed, revolutions/hr.
- Q — heat lost in cooling, Btu.
- q — heat transfer rate, Btu/hr.
- r — thermal resistance, r_m—of metal, r_f—of fouling.
- T — temperature, F., T_1—start of cooling, or point at which self-insulation starts to form, T_1'—initial temperature (Case IV), T_2—at end of cooling period, T_a—of ambient air, T_d—of dead air space, T_g—of ground below tank, T_h—of heating medium, T_i—of liquid in tank, T_m—freezing point, T_w—at tank wall.
- ΔT — temperature difference, F; ΔT_m—mean temperature difference, F.
- U — overall coefficient, Btu/(hr.) (F.) (sq. ft.); U_b—at tank bottom, U_c—of coil, U_d—of dead air to the tank contents, U_i—through insulation, U_s—at sides, U_t—at top, U_2—at area A_2.
- V — velocity, ft./hr.
- W — flow, lbs./hr.
- β — Coefficient of Volumetric expansion, cu. ft./(cu. ft.)(°F)
- Θ — Time, hrs. Θ_c—cooling, Θ_h—heating.
- λ — Latent heat of fusion, Btu/lb.
- μ — Viscosity of fluid, lbs./(ft.)(hr.), μ_f—at average film temperature.
- ρ — Density, lbs./cu. ft.

Based on a paper "The Design of Heating Coils for Storage Tanks" presented at the Second National Heat Transfer Conference, Chicago, Aug. 17-20, 1958.

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How Hydrogen Affects Insulation

Use these thermal conductivity factors when designing internal insulation for hydrogen atmospheres

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THE METAL TEMPERATURES of pressure vessels in hydrogen service are sometimes reduced by the use of internal insulation. Since the thermal conductivity of hydrogen is much greater than that of air or the common gases (see Table 1) the porous insulation has a greater ability to conduct heat.

The low thermal conductivity of porous materials depends in a large part upon the many gas pockets. These transfer little heat because of relatively low thermal conductivity of the contained gas. Since the thermal properties of such insulation materials are tested in ordinary atmospheres and so reported, higher thermal conductivities are encountered in hydrogen service.

Nonken[2] reported "The curves for the refractories completely filled with hydrogen show that the conductivity of the porous refractories increases to as much as three times their conductivity with air in the pores. The conductivity of the insulating fire brick varies directly as the percentage of hydrogen when various percentages of hydrogen and nitrogen were used to fill the brick."

Heat transfer through a porous solid material occurs as:

1. Conduction through the solid itself
2. Convection through the gas pockets
3. Radiation between surfaces of individual particles

Data on two typical insulating firebrick materials recommended for services in atmospheres containing hydrogen are shown in Figures 1 and 2 and in Table 2.[3] Figures 1 and 2 are for atmospheres of air or pure hydrogen. Correction factors for hydrogen diluted with nitrogen appear in Figure 3.

Example: Determine the thermal conductivity of the denser firebrick (B in Table 2) at a mean temperature

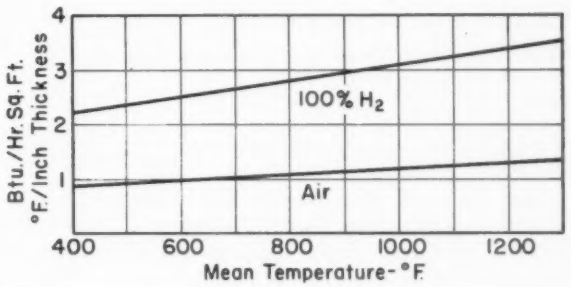

FIGURE 1—Thermal conductivity of firebrick A in atmospheres of air and 100 percent hydrogen.[3]

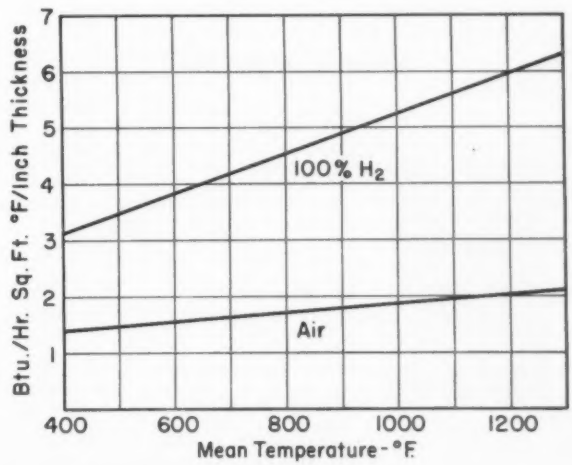

FIGURE 2—Thermal conductivity of firebrick B in atmospheres of air and 100 percent hydrogen.[3]

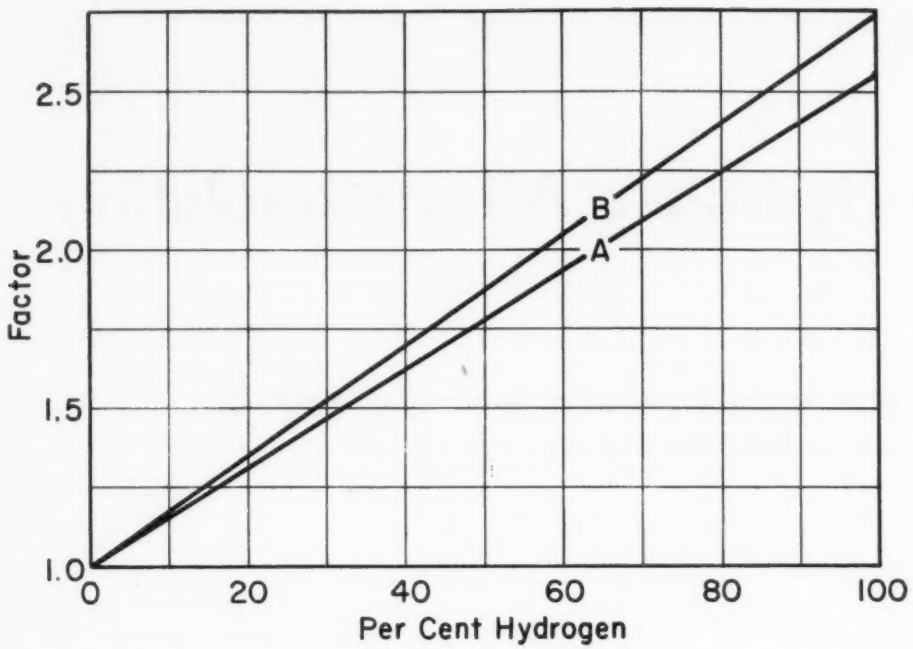

FIGURE 3—Thermal conductivity correction factors for firebrick A and B for various concentrations of hydrogen diluted with nitrogen.[3]

of 1000 F. for a gaseous mixture containing 30 volume percent of hydrogen.

From Figure 2—Conductivity is 1.84 Btu/hr. sq. ft. F./inch thickness. From Figure 3—Factor is 1.53. Conductivity of the firebrick in 30 percent hydrogen is $1.84 \times 1.53 = 2.82$ Btu/hr. sq. ft. F./inch.

Note: Thermal conductivity data are presented in conventional engineering form. The data in Table 1 are in Btu/hr. sq. ft. F./ft. The data on insulating materials are in Btu/hr. sq. ft. F./inch.

About the Author

Rubin

Frank L. Rubin has a 16-year background in the chemical, petrochemical and petroleum industries. Most of that time has been spent in the testing of heat transfer equipment. Now with Downington Iron Works, he has been a senior job engineer on AEC projects, chemical plants, and refineries while with Catalytic Construction Co. He has also been with The Lummus Co. in the Heat Exchanger division, and with Stauffer Chemical Co. in the Research division. Rubin has a B.A. degree from Brooklyn College, a B.S. degree in chemical engineering from Cooper Union School of Engineering, and has completed graduate work at the Polytechnic Institute of Brooklyn. He is a member of ASME and AICHE.

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TABLE 1—Thermal Conductivity at Atmospheric Pressure of Some Gases[1]

F	Hydrogen	Nitrogen	Air	Methane	Carbon Dioxide
60	0.1016	0.0145	0.0149	0.0195	0.0094
212	0.1222	0.0178	0.0177	0.0262	0.0135
392	0.1458	0.0213	0.0217	0.0344	0.0185
572	0.1693	0.0249	.....	.....	.....

Note: Conductivity in Btu/hr. sq. ft. F/ft.

TABLE 2—Properties of Two Firebricks Recommended for Use in Atmospheres Containing Hydrogen

PROPERTY	FIREBRICK A	FIREBRICK B
Recommended use limit, F	2000	2600
Melting point, F	2750	3000
Average bulk density, lbs./cu. ft.	25.3	41.6
Average modules of rupture, psi	68	166
Average cold crushing strength, psi	95	154
Average apparent porosity, percent	85	72
Average chemical analysis, percent		
Alumina, Al_2O_3	37.7	40.1
Silica, SiO_2	45.4	54.6
Ferric Oxide, Fe_2O_3	1.0	2.4
Titanium Dioxide, Tio_2	1.3	1.2
Lime, CaO	14.2	1.5
Magnesia, MgO	0.1	0.1
Alkalies as Na_2O	0.2	0.4
Coefficient of linear reversible thermal expansion, in./in. F	3.0×10^{-6}	2.2×10^{-6}
Mean specific heat, Btu/lb/F between 80 F and		
500	0.210	0.210
1000	0.232	0.232
1500	0.248	0.248
2000	.....	0.259

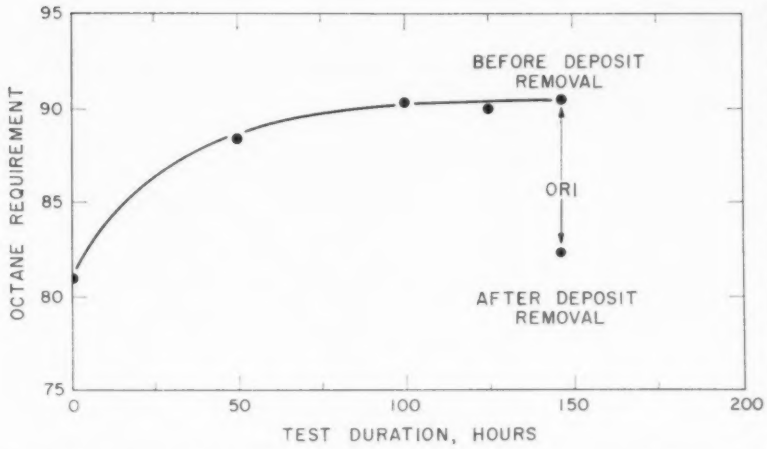

FIGURE 1—Combustion-chamber deposits add as much as 10 octane numbers to the requirement of a new engine.

Motor Oils Decide Octane Needs, Too

Deposits influence engine octane requirements. Since these deposits are a function of the motor oil used, here are some points to remember when picking the components of a good lubricant.

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THE OCTANE NUMBER required by an engine is governed not only by compression ratio but also by the deposits formed in the combustion chambers. Deposits are derived from motor oils as well as from gasolines; therefore, the composition of the motor oil is intimately tied to octane requirement. An understanding of why and how much motor-oil deposits contribute to spark knock and surface ignition could point the way to worthwhile octane savings.

In aggravating spark knock, combustion-chamber deposits add as much as 10 octane numbers to the requirement of a new engine when equilibrium is reached after a few thousand miles of driving.[2] The amount of deposits contributed by motor oils was determined as early as 1926,[5] but recent studies have shown that the amount—as such—has little to do with octane requirement. Composition and thermal-insulating properties are far more important.[7] Tail-end components of low volatility in the oil cause particularly harmful deposits.[1] And the additives used, especially viscosity-index improvers, raise octane requirement appreciably.[8]

In surface ignition, glowing of carbonaceous deposits ignites the fuel-air charge and initiates a flame front at a time different from that of the normal flame front initiated by the spark plug. Flame fronts either before or after the spark can lead to engine noise, loss of power output, and—if severe—to engine damage.[6] Octane numbers, above those needed to eliminate spark knock, resist surface ignition; gasoline additives containing phosphorus reduce it.[6] Although no quantitative information is available about the effect of motor-oil additives, inorganic elements in additives form ash and might be expected to affect surface ignition by changing the glow properties of the deposits.

To learn more about how motor-oil composition affects both octane-requirement increase (ORI) and and surface ignition, engine studies have been carried out to measure the contributions of the separate components of motor oils. ORI attributable to base oil, viscosity-index improver, and other additives was measured in V-8 engines. In the complex problem of surface ignition, the effect of ash-forming elements in additives was studied in a single-cylinder CFR engine, modified so that surface ignition could be accelerated and the flame fronts arising from it could be counted. To confirm the information obtained for each motor-oil component, surface-ignition properties of six commercial SAE 10W-30 oils were determined in further tests.

Deposits Demand More Octanes. ORI measurements were made both on single-graded and on multi-graded oils. Single-graded oils of five different viscosities—SAE 5W, 10W, 20, 30, and 40 provided a range of tail-end volatilities. Bright stock—a deasphalted residual oil—was added when exceptionally low tail-end volatility was desired. Viscosity-index improvers were added as needed to make SAE 5W-20, 10W-30, and 20W-40 oils. Detergents and inhibitors were used in amounts up to 6 percent to impart heavy-duty lubrication properties.

Engine tests on each oil were carried out in overhead-valve V-8 engines of 8:1 compression ratio.[8] Operation on leaded fuel for 150 hours simulated driving on the road at 30 miles per hour for 4,000 to 5,000 miles. At this mileage, build-up of deposits in the combustion chambers

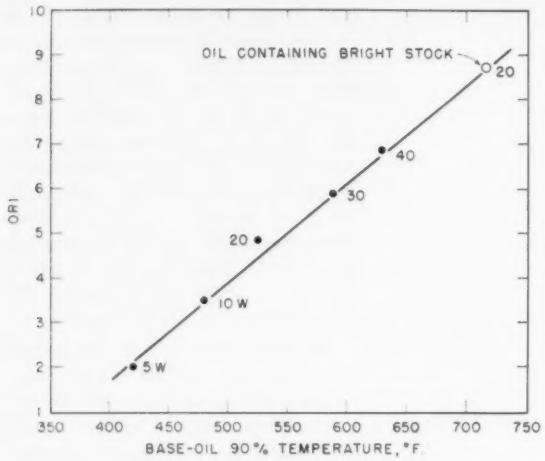

FIGURE 2—ORI increases linearly as the 90 percent temperature increases.

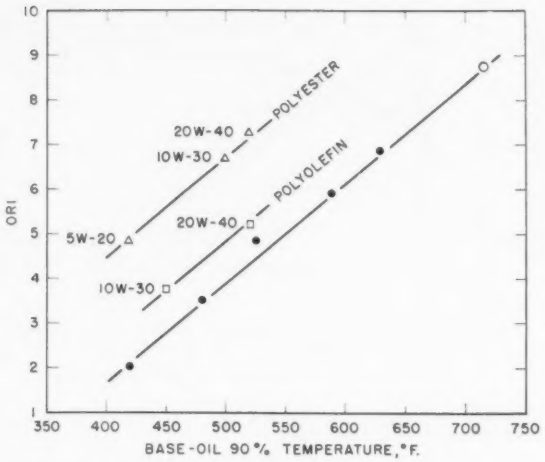

FIGURE 3—VI improvers of the polyester type add three units to ORI when compared to the base oils.

—and, consequently, octane requirement of the engine—reached equilibrium. As shown in Figure 1, ORI was measured as the difference in requirement before and after removal of deposits. Requirement was determined at the trace-knock level on primary reference fuels.

How Motor Oils Affect ORI. Tail-end volatility of the base oil, type of VI improver, and type of detergent and inhibitor determine how much a motor oil contributes to ORI.[8] Tail-end volatility was measured in terms of the vapor temperature at which 90 percent of the oil distilled under a pressure of 1 mm.

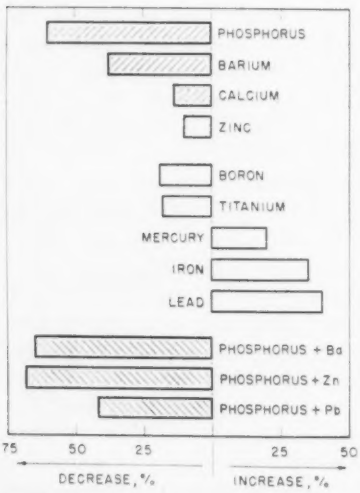

FIGURE 4—Some of the inorganic elements which are commonly present in motor oil reduce surface ignition.

of mercury. The two viscosity-index improvers investigated represented the two widely used types—polyester and polyolefin. The four detergents were commercially available materials: a P_2S_5-olefin product, a phenate, and two sulfonates. The two inhibitors were typical commercial products: a zinc dithiophosphate and a sulfurized hydrocarbon.

ORI increases linearly as the 90 percent temperature increases. Figure 2 shows that the increase is one unit for every 45 F. For distillate stocks, ORI also follows closely the SAE viscosity classification. But when bright stock was used in making a 20-grade oil—represented by the open point—ORI jumped 4 units. Tail-end volatility thus determines ORI directly and better measures the harm caused by high-boiling components than does SAE viscosity.

VI improvers are second only to volatility in effort on ORI. Figure 3 shows that ORI values for the VI improvers paralleled those found for base oils. Volatility thus exerts a constant and equal effect in the presence of either improver. But, at any given volatility, the polyester improver added three units to ORI, and the polyolefin improver added only one.

The detergents had a small but measurable effect on ORI, whereas the inhibitors were harmless. The changes in ORI are shown in Table 1. No clear influence on ORI can be assigned to the amount or kind of metal present in the additive. The organic structure of the additive molecule may be more important.

Surface Ignition Is Measured. Surface-ignition studies were made both on commercial and on experimental additives. The commercial detergents and inhibitors contained phosphorus, barium, calcium, or zinc, or some combination of these elements. The experimental additives were oil-soluble compounds synthesized in the form of detergents; they contained phosphorus and metals not normally found in additives: boron, titanium, mercury, iron, and lead. For testing, 2 percent of each additive, blended into 30-grade oil, provided 0.1 to 0.6 percent of ash-forming element in the oil.

All additives were tested in a single-cylinder L-head CFR engine with a compression ratio of 8:1. The engine was modified with an external circulating system that served to flood the piston rings with

TABLE 1
Effects of Detergents and Inhibitors

Additive	Metal in Oil, %	Effect on ORI
Detergent		
Barium-P_2S_5-Olefin	0.17	—0.5
Barium Phenate	0.53	+0.5
Barium Sulfonate	0.07	+1.0
Calcium Sulfonate	0.03	+1.0
Inhibitor		
Zinc Dithiophosphate	0.11	0
Sulfurized Hydrocarbon	0	0

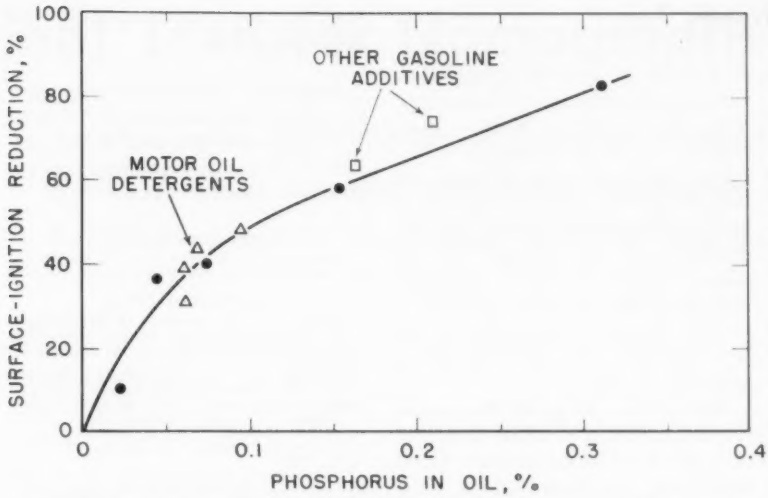

FIGURE 5—Unlike additives in gasoline, phosphorus compounds in motor oils reduce surface ignition without regard for the kind of phosphorus compound used.

oil. The resulting high oil consumption gave a high level of surface ignition. Controlling oil consumption by controlling the rate of oil circulation gave good repeatability between tests. A proportioning pump was used so that one quart of oil passed by the rings and entered the combustion chamber over the test period of 50 hours. The engine was operated with leaded fuel on a cycle consisting of 2 minutes and 15 seconds of wide-open throttle at a speed of 900 rpm, and 45 seconds of idle at 700 rpm.

Abnormal flame fronts in the combustion chamber, initiated by glowing deposits, were detected by an ionization gap.[4] A voltage was applied across the gap; when a flame front passed and the gas ionized, the resistance across the gap was momentarily reduced. The resultant current pulse, after amplification, actuated a counter. A timing circuit blocked out the counter when a normal flame front, initiated by the spark plug, passed the gap. Dividing the total count by the number of test hours gave surface-ignition rate. The rate with additives was compared with that for base oils.

Additives Affect Surface Ignition. All of the inorganic elements present in the additives tested showed some effect on surface ignition. As shown in Figure 4, phosphorus, barium, calcium, and zinc—elements commonly present in motor oils—reduce surface ignition. Phosphorus gives by far the largest reduction. Barium is more effective than either calcium or zinc. Among the unusual metals in the experimental additives, boron and titanium are moderately effective, whereas mercury, iron, and lead increase surface ignition.

Two or more elements in an additive did not reduce surface ignition in a regular cumulative manner. Thus, phosphorus and barium, or phosphorus and zinc, gave only a slightly greater reduction than would be expected from phosphorus alone. On the other hand, phosphorus together with lead not only canceled the bad effects of lead but also reduced surface ignition markedly—a net effect greater than would be expected from phosphorus alone. With combinations of other elements, interactions that affect surface-ignition undoubtedly also occur. In general, however, the most effective element present governed the surface-ignition results.

Further testing of compounds containing phosphorus explored the effects of concentration and structure, as shown in Figure 5. An organic phosphorus compound—a commercial gasoline additive—when tested in the oil in varying amounts showed greater reduction of surface ignition at higher concentrations. The triangular points were obtained with a phosphorus-containing motor-oil detergent that differed markedly in structure from the gasoline additive. The square points represent two dissimilar phosphorus compounds also used in gasolines for reducing surface ignition. The close fit of these points to the curve suggests that reduction of surface ignition depends only on the amount and not on the kind of phosphorus compound used. Such behavior of phosphorus compounds in motor oils is surprising; in gasolines, the effectivenes depends on structure as well as on amount of phosphorus.[3]

Motor Oils Give Octane Bonus. With some understanding of the factors that contribute to ORI and to surface ignition, motor-oil refiners are in a position to offer a real octane bonus. The right choice of components provides the key.

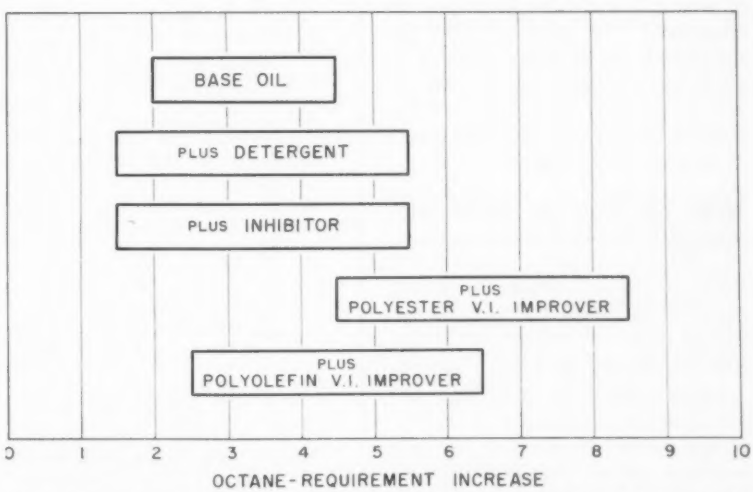

FIGURE 6—The difference between the poorest choice of oil additives and the best can be an octane bonus of six units.

TABLE 2
ORI Range for Oil Grades

Oil, Grade	ORI
5W	1.5 to 4.5
10W	2.5 to 5.5
20W	3.5 to 7.0
30W	4.5 to 8.0
40W	5.5 to 9.0

TABLE 3
Phosphorous Reduces Octane Requirement

Oil	Octane Number to Suppress Surface-Ignition	Phosphorus, %
A	86	0.19
B	89	0.12
E	96	0.06
C	97	0.08
D	99	0.04
F	100	0.09

The ORI of a fully blended motor oil can be easily calculated when the effects of volatility, VI improver, detergent, and inhibitor are known. Figure 6, for example, shows the cumulative contributions of the components of 10W-30 oils. Because these oils are made from either 10W or a blend of 5W and 10W base oils, volatility contributes 2.0 to 4.5 units to ORI. Detergents can subtract 0.5 or add 1.0; inhibitors have no effect. The polyester VI improver adds 3.0, whereas the polyolefin VI improver adds 1.0. The poorest choice of components for a fully blended 10W-30 oil results in an ORI of 8.5; the best choice, 2.5—an octane bonus of six units.

The same principles apply to single-graded oils. Because VI improvers are absent, only the effects of volatility and detergents need be considered. The range of ORI for each grade of oil given in Table 2. Choosing the most-volatile base oil in each grade and the barium-P_2S_5-olefin detergent gives an ORI bonus of at least three units.

What can you do about surface ignition? Phosphorus in motor oils reduces surface ignition and therefore should reduce the octane number needed to suppress it. Engine tests on six commercial 10W-30 oils are shown in Table 3.

Large amounts of phosphorus reduce surface ignition and needed octane number as much as 14 units over the poorest oil. With smaller amounts of phosphorus, the erratic results suggest that a concentration of at least 0.1 percent is needed to control surface ignition. Phosphorus, then, conveniently added to commercial oils in the detergent or inhibitor molecule, offers an easy and inexpensive way of reducing surface ignition and saving octanes. Barium, calcium, and zinc in these oils also reduce surface ignition, although they have less influence than phosphorus. Barium was present in the best three oils, calcium in the others, and zinc in all.

Base stocks and additives for motor oils must first of all be chosen to do a good job of lubricating. Good detergency, oxidation stability, antiwear properties, and anticorrosion properties largely dictate composition. But, because of the choice of components is reflected in ORI and surface-ignition, composition must increasingly be viewed in this light. The rewards are savings of expensive octanes for the petroleum industry, and better performance from tomorrow's automobile engines for the motoring public.

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ACKNOWLEDGMENT

The authors are grateful to T. O. Wagner for the modification of the oil-circulation system.

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Heat Transfer Nomographs

Part 6—Internal heat transfer for Reynolds numbers larger than 10,000

PART 7—Heat transfer coefficients for liquids and gases inside tubes

Part 8—Heat transfer coefficients for liquids and gases outside tubes

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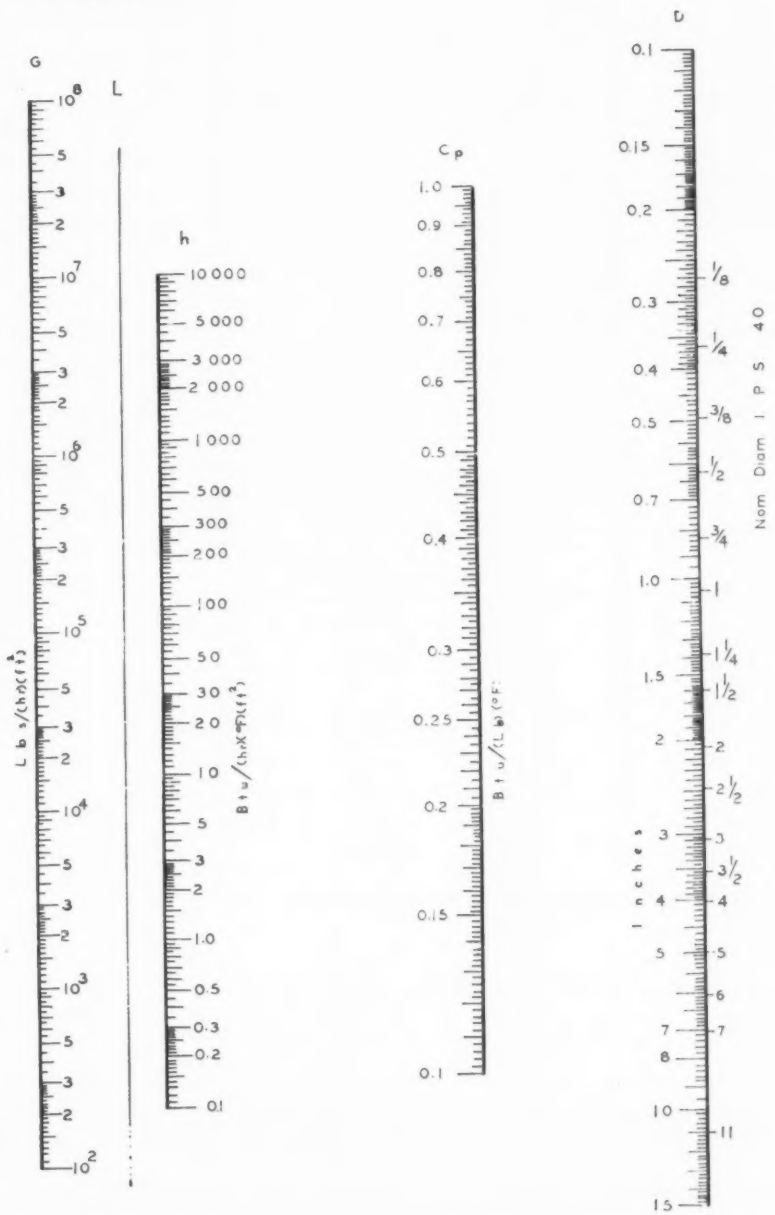

HERE ARE two nomographs for determining film coefficients. Nomographs 15 can be used for finding the heat transfer coefficient for gases inside tubes while No. 16 is for liquids. Time is saved due to the resolution of the fractional power mass velocity coefficients into nomograph form.

Film coefficients for gases, Reynolds number larger than 2,100, inside tubes—Nomograph No. 15 is designed to indicate the simplified equation for gases:

$$h = 0.0144\, C_p G^{0.8}/D^{0.2}$$

Where: h, Film coefficient, Btu/h. sq. ft. F.
C_p, Specific heat, Btu/lb. F.
G, Mass velocity, lb./h. sq. ft.
D, Inside diameter, feet

Example: Find the value of h for a gas flowing inside a 1 inch Std. pipe (I.P.S. 40) if G is 8,000 lb./h. sq. ft.; C_p, 0.24 Btu/lb. F.

Solution: From Nomograph 15 the value of h is found to be 7.1 Btu/h. sq. ft. F.

Key : G — C_p : L
L — D : h

Heat transfer in liquids inside tubes, in the intermediate zone ($2{,}100 < Re < 10{,}000$)—In this zone Kern[13] recommends a graph,[14] and others recommend similar graphs.[4, 8, 10]

Nomograph No. 16 is used to simplify the calculations of the J_h factor, which appears in the Kern chart.

The nomograph solves the equation

FIGURE 15—Film coefficients for gases inside tubes for Reynolds numbers larger than 2100.

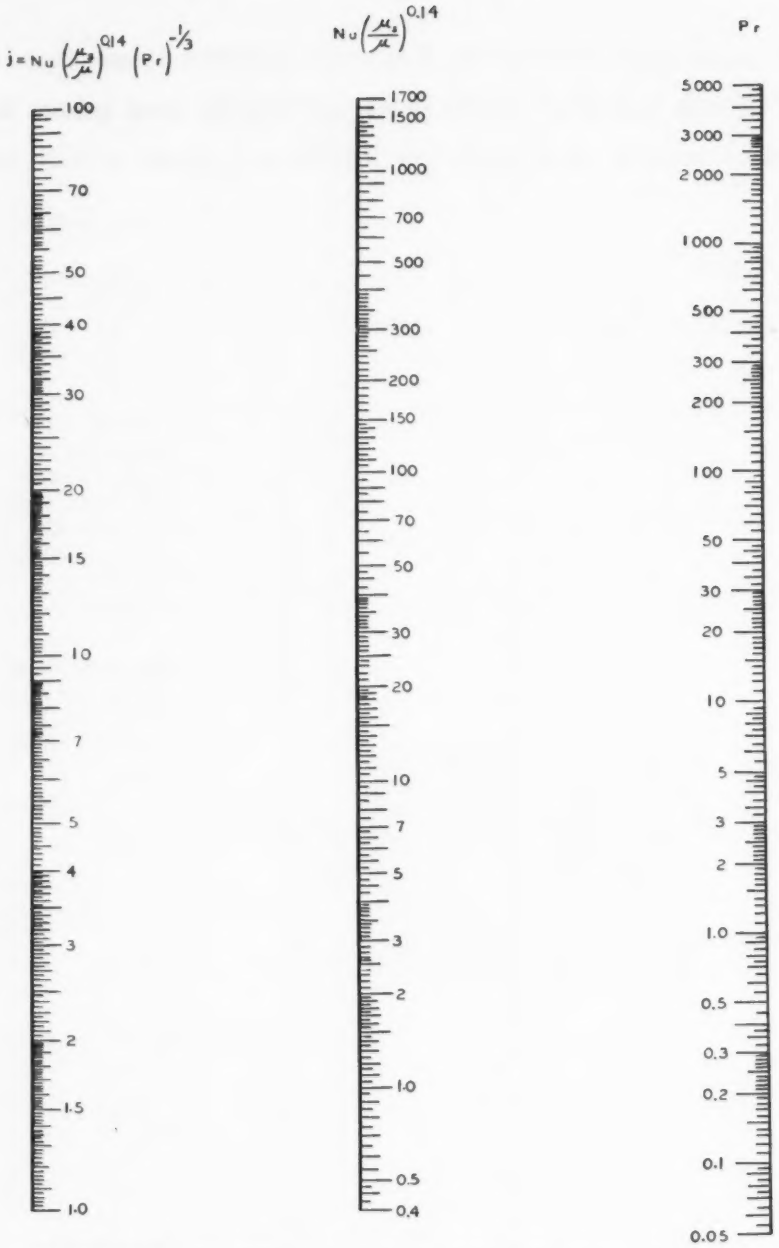

FIGURE 16—Heat transfer for liquids inside tubes in the intermediate zone.

$$J_h = Pr^{1/3} Nu \left(\frac{\mu_s}{\mu}\right)^{0.14}$$

Where: J_h, Dimensionless, factor, which appears in the Kern chart[32]
Pr, Prandtl number
Nu, Nusselt number
μ, Viscosity at the fluid temperature, centipoises
μ_s, Viscosity at the wall temperature, centipoises

Example: Find the (Nusselt) Nu $\left(\frac{\mu_s}{\mu}\right)^{0.14}$, if $J_h = 30$, Prandtl = 10.

Solution: Using Nomograph No. 16 Nu $\left(\frac{\mu_s}{\mu}\right)^{0.14}$ is found to be 65.

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TO BE CONTINUED

The Solubility Of *i*-Butane in Water

Experimental and smoothed data are presented here for pressures up to 320 psia at 100, 160 and 220 F.

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THIS ARTICLE covers the two-phase equilibrium between the water-rich liquid phase and the hydrocarbon-rich gas phase. In this investigation the pressure of the system was held below that necessary for the appearance of a third phase, a hydrocarbon-rich liquid phase.

The equilibriating equipment and the analytical techniques were essentially the same as those described earlier.[1,2] A static method is used whereby the water and the *i*-butane are placed into an equilibrium cell, the cell is rocked for several hours, then the water-rich liquid phase is sampled directly into the analytical train.

Materials Used. The research grade *i*-butane used in this work was supplied by the Phillips Petroleum Company at a certified purity of 99.9 mole percent. No further purification was made. The water was taken from laboratory distilled water supply and boiled to remove any dissolved gases.

Experimental Results. The experimental data for the solubility of *i*-butane in water are shown in Table 1 at pressures from 32.6 to 315 psia. These data are plotted in Figure 1 to show the effect of pressure on the solubility of the *i*-butane in the water-rich liquid at temperatures of 100,

TABLE 1—EXPERIMENTAL DATA—TWO PHASE REGION
Concentration of *i*-Butane in Water-Rich Liquid Phase

100F		160F		220F	
Total Pressure psia	Mole Fraction X 10^5	Total Pressure psia	Mole Fraction X 10^5	Total Pressure psia	Mole Fraction X 10^5
73.7	4.30	161.7	6.50	315	7.27
71.2	4.18	155.7	5.75	300.7	6.70
70.7	5.25	142.7	5.17	282.7	6.25
64.9	5.26	125.7	4.51	273.7	5.70
61.8	4.12	100.7	3.68	261.7	6.05
60.7	3.92	75.0	2.55	258.7	5.47
57.7	4.40	....	....	225.7	4.85
55.6	2.74	....	....	177.7	3.68
51.4	3.43	....	....	67.7	1.16
49.7	1.98	....	....	....	....
48.4	2.56	....	....	....	....
42.7	1.70	....	....	....	....
34.7	1.99	....	....	....	....
32.6	1.10	....	....	....	....

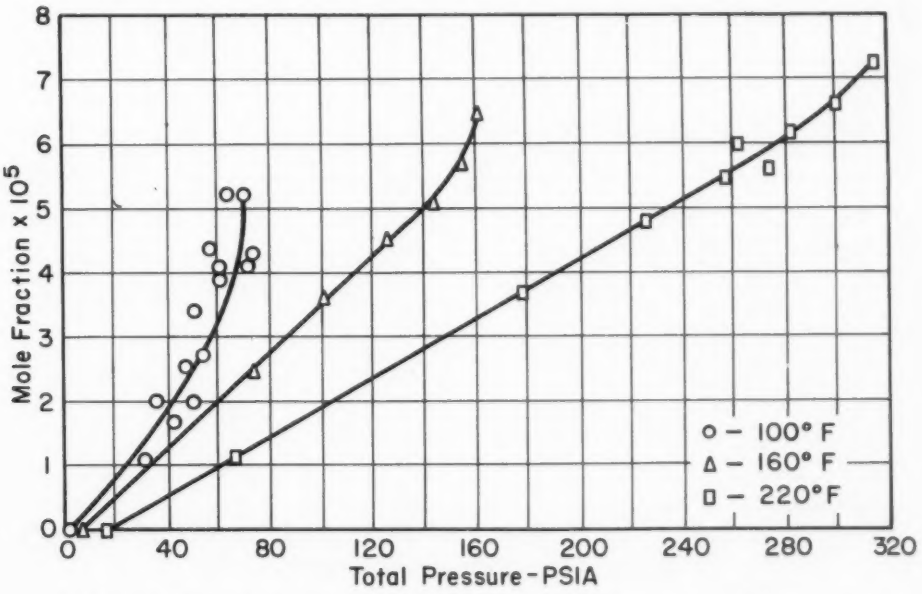

FIGURE 1—Concentration of iso-butane in water-rich liquid phase region vs. total pressure.

160 and 220 F. The experimental points are shown in Figure 1. Although there is a maximum deviation of 18 percent (at 100 F.), these are considered satisfactory data because of the extremely low concentrations of the hydrocarbon solubility in the water. The reproducibility of the data was very good at the 160 and 220 F. isotherms.

TABLE 2—SMOOTHED DATA—TWO PHASE REGION
Concentration of *i*-Butane in Water-Rich Liquid Phase

100F		160F		220F	
Total Pressure psia	Mole Fraction X 10^5	Total Pressure psia	Mole Fraction X 10^5	Total Pressure psia	Mole Fraction X 10^5
10	0.35	20	0.50	20	0.08
20	0.75	40	1.25	40	0.55
30	1.25	60	2.00	60	0.98
40	1.85	80	2.75	80	1.45
50	2.45	100	3.50	100	1.90
60	3.25	120	4.25	120	2.35
70	5.00	140	5.00	140	2.83
....	....	150	5.45	160	3.27
....	....	160	6.25	180	3.75
....	....	....	....	200	4.22
....	....	....	....	220	4.65
....	....	....	....	240	5.15
....	....	....	....	260	5.55
....	....	....	....	280	6.10
....	....	....	....	300	6.60
....	....	....	....	310	7.27

The experimental data were smoothed from large charts similar to Figure 1. These smoothed data are shown in Table 2. It is interesting that this system does not exhibit a minimum solubility at this temperature range. Most of the straight chain hydrocarbons form minimum solubility curves.

In Figure 2 the smoothed data of this work is compared at 100 F. with the solubility of methane,[3] ethane,[2] propane[1] and *n*-butane.[4] Figure 2 shows that the heavier hydrocarbons are considerably less soluble in water.

ACKNOWLEDGMENTS

This work was carried out under a National Science Foundation Grant. The authors also wish to acknowledge the assistance of Phillips Petroleum Company who supplied the research grade *i*-butane used in this investigation.

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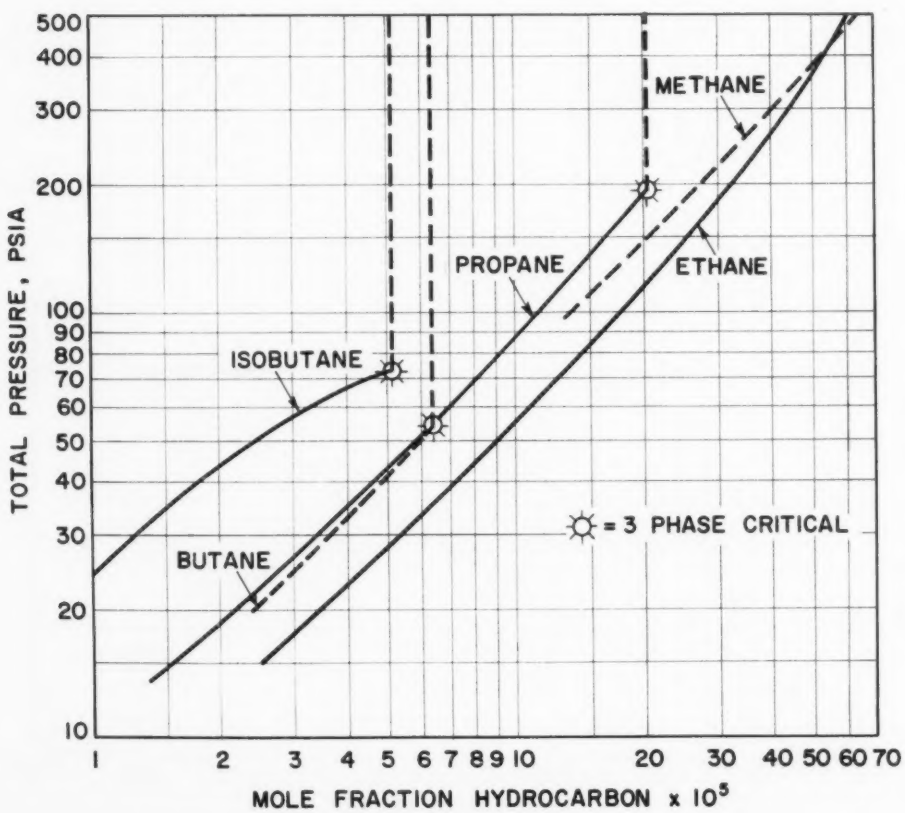

FIGURE 2—A comparison of hydrocarbon solubility in water at 100 F.

Applied Hydrocarbon Thermodynamics

Part 10A: Charts for Making Compressor Calculations

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California Research Corporation
Richmond, Calif.

COMPRESSOR DESIGN includes calculations of (1) temperature rise of the gas, (2) the work of compression, and (3) the compressor size. Exponents defining temperature and volume changes with pressure are useful in making these calculations for both centrifugal and reciprocating compressors. Charts given in this section are of use in making such calculations, especially for reciprocating compressors.

* Present address: Oklahoma State University, Stillwater, Okla.

Generalized relationships were developed in previous installments (Parts 7, 8, and 9) for reversible adiabatic (isentropic) and reversible polytropic paths. From these correlations, charts giving exponents for eight typical gases have been prepared and are given here. Two other charts, giving the isentropic exponent as a function of gas gravity, olefin content, temperature, and pressure, were prepared and are included. Also, an irreversibility correction to the temperature change exponent has been developed.

In addition to these exponent charts, graphical solutions for final temperature, volumetric efficiency, and

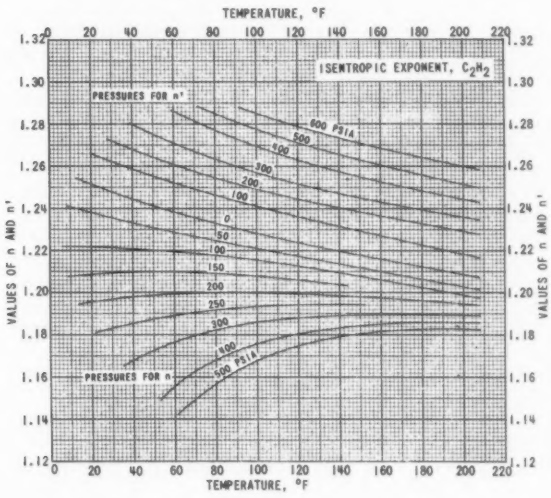


FIGURE 10.1—Isentropic exponents for acetylene.

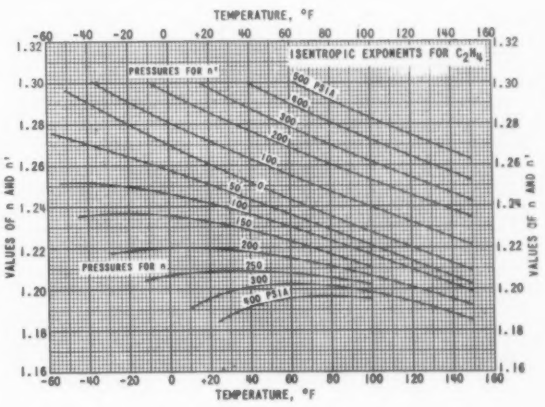


FIGURE 10.2—Isentropic exponents for ethylene.

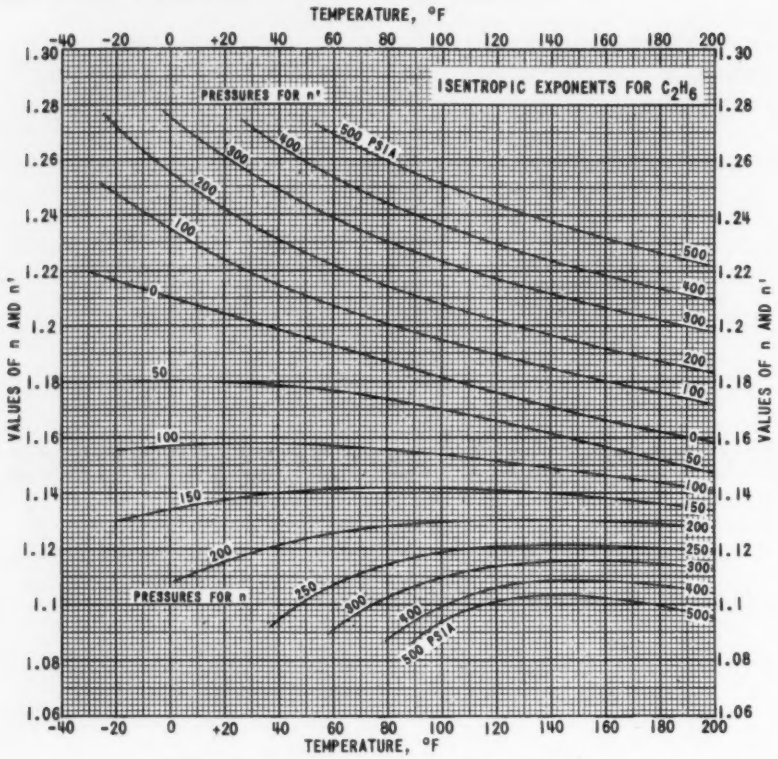


FIGURE 10.3—Isentropic exponents for ethane.

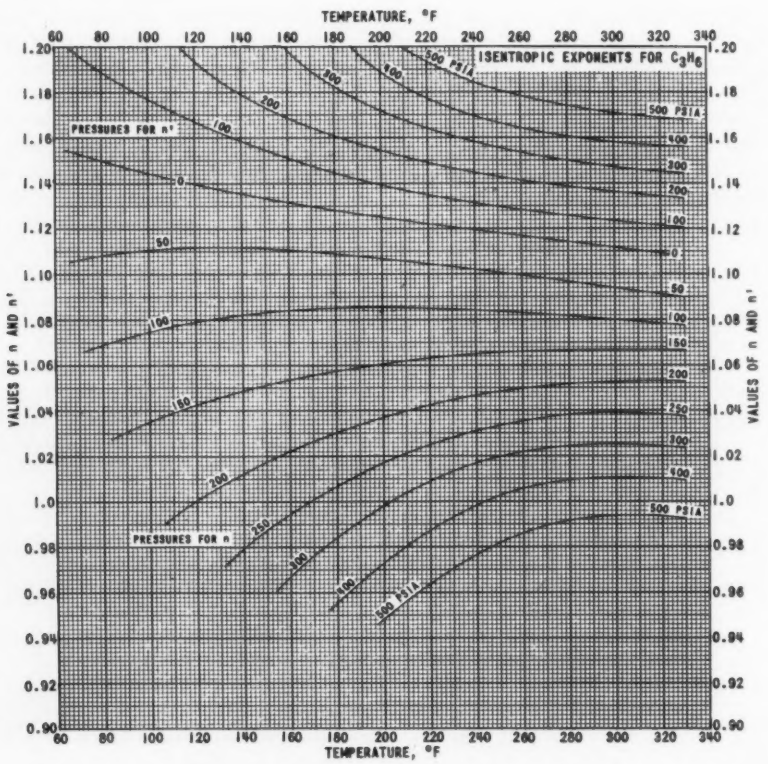


FIGURE 10.4—Isentropic exponents for propylene.

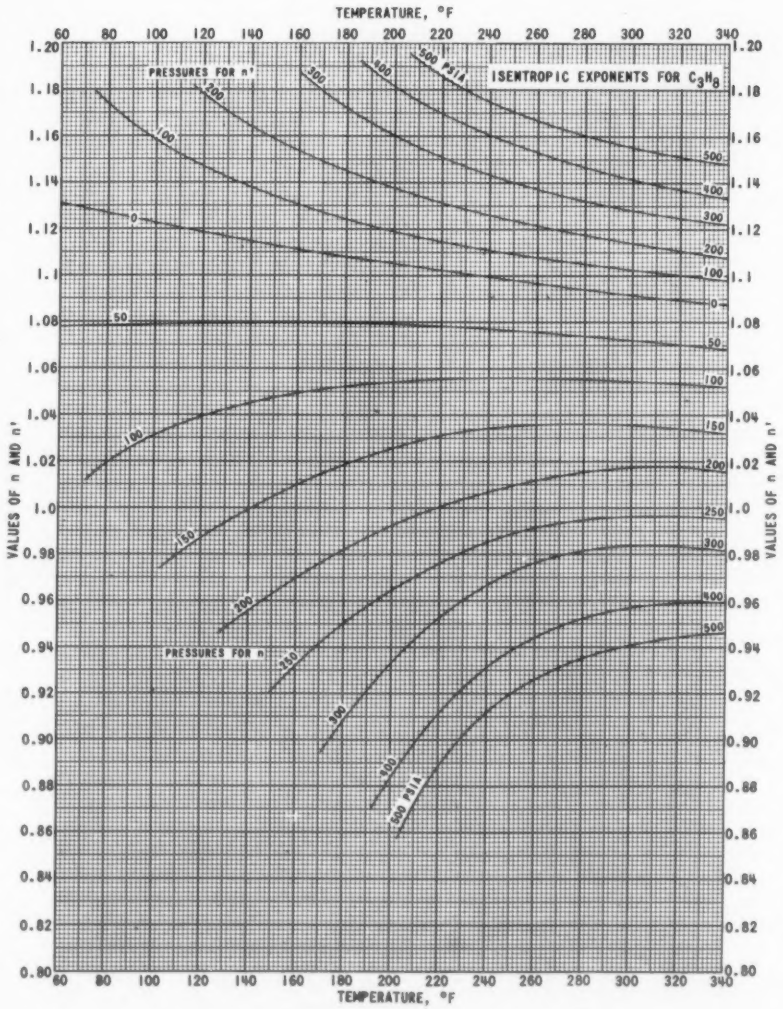


FIGURE 10.5—Isentropic exponents for propane.

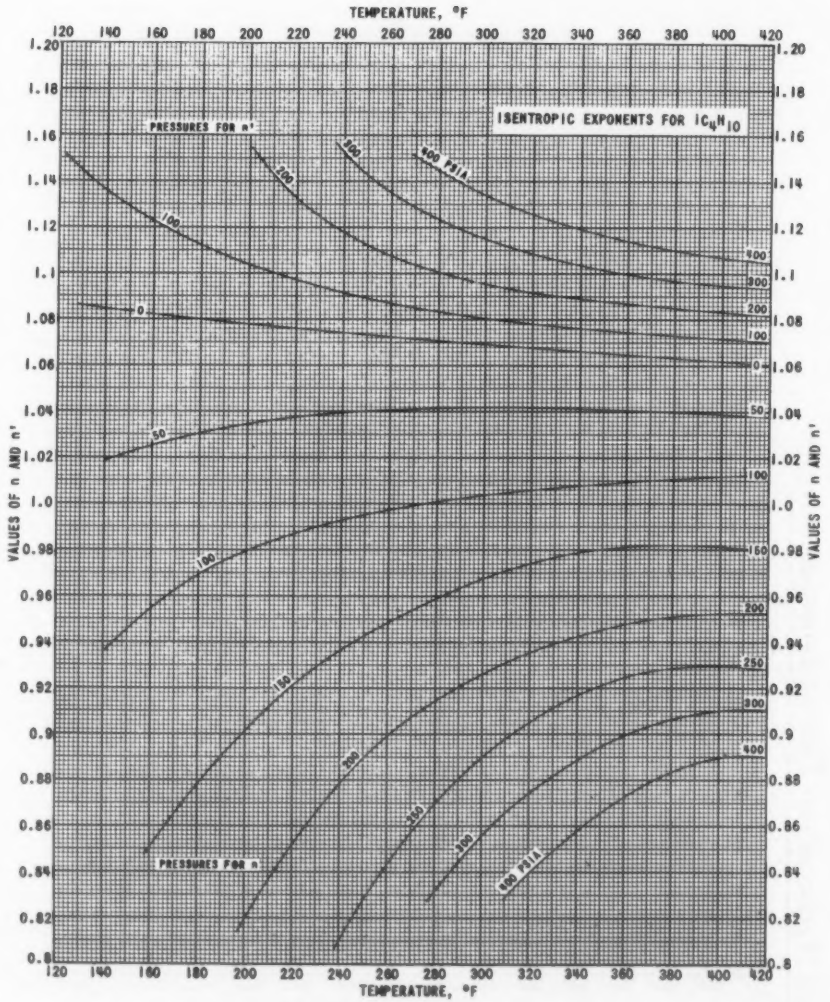


FIGURE 10.6—Isentropic exponents for isobutane.

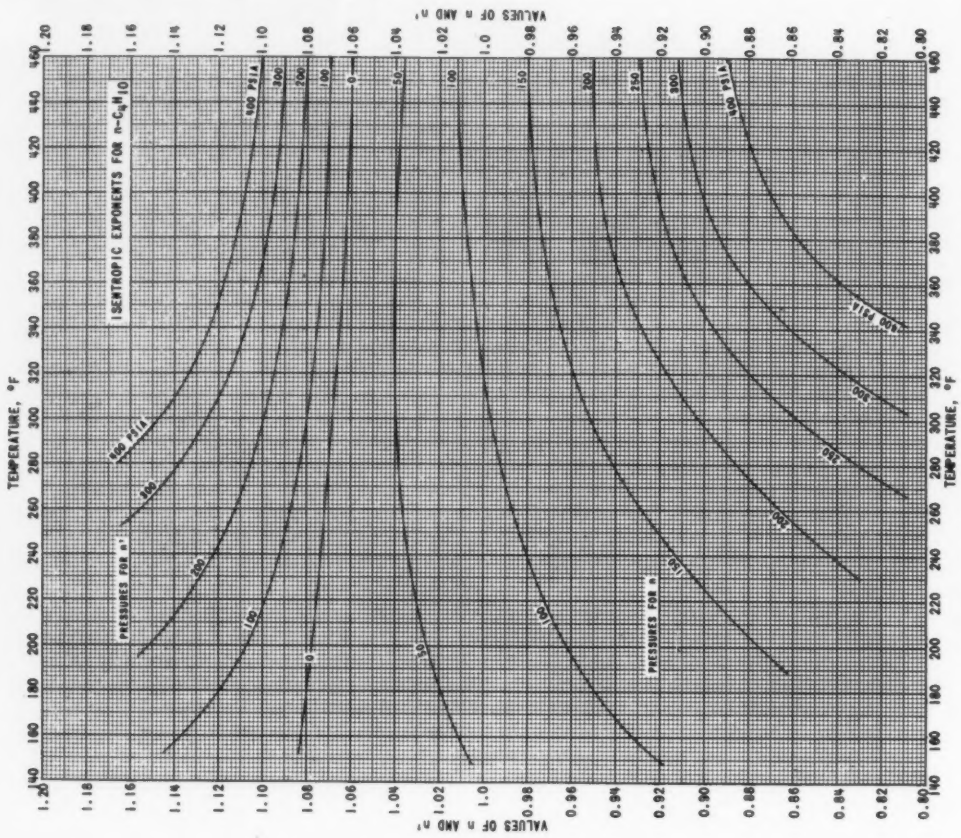


FIGURE 10.7—Isentropic exponents for N-butane

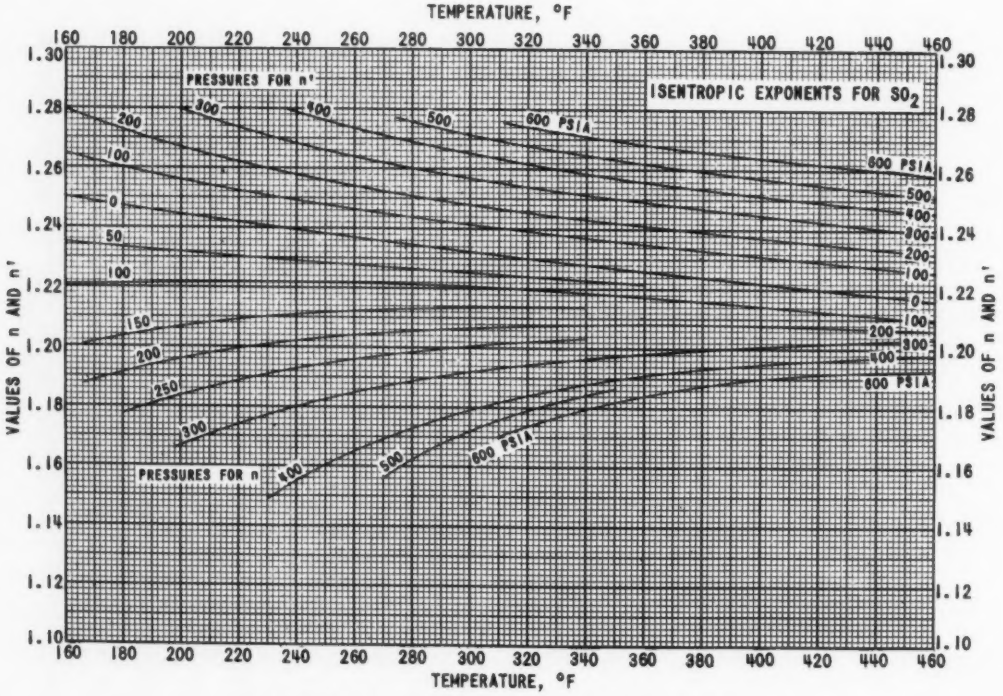


FIGURE 10.8—Isentropic exponents for sulfur dioxide.

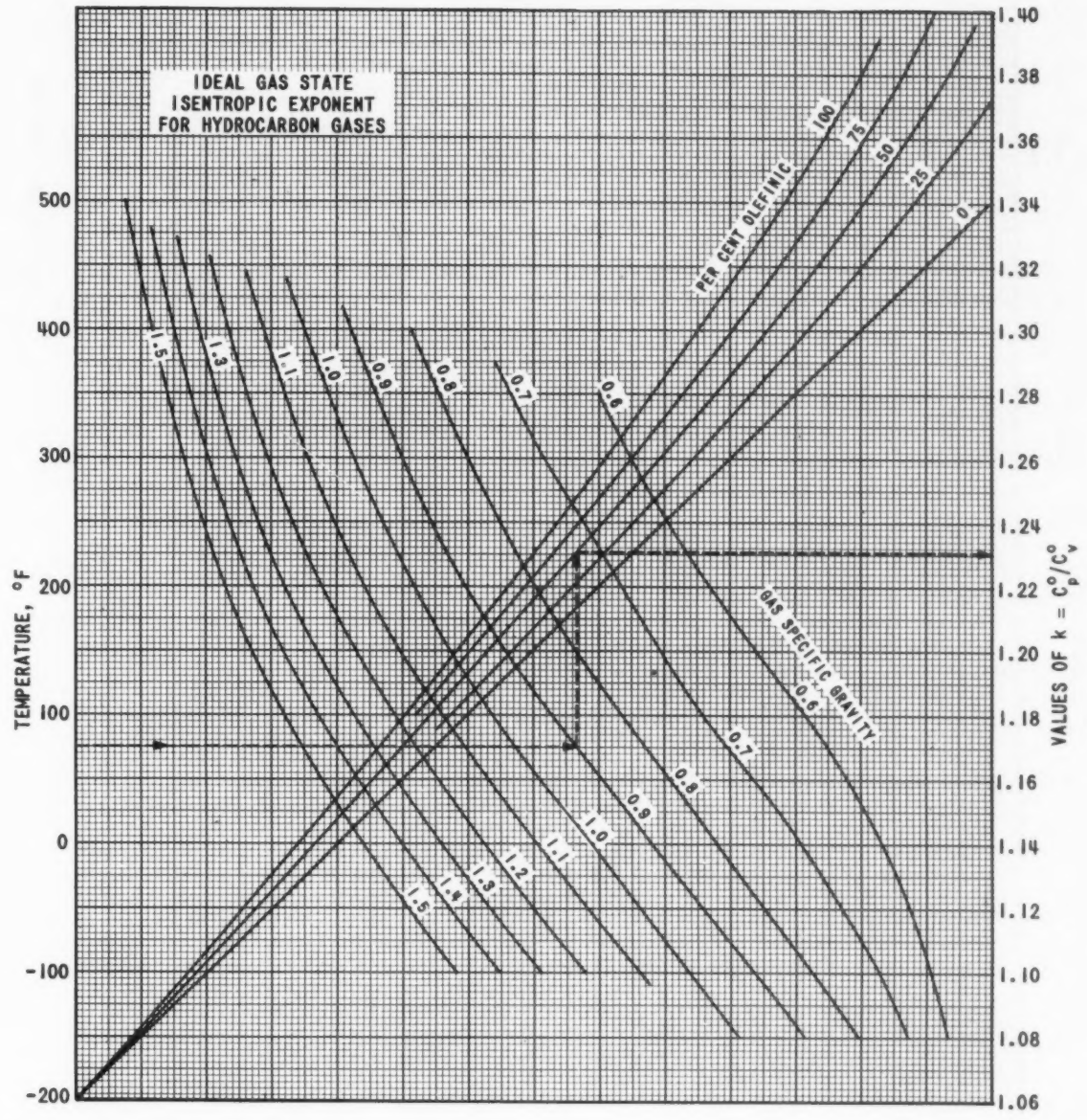


FIGURE 10.9—Ideal gas state isentropic exponent (heat capacity ratio) for hydrocarbon gas mixtures as a function of temperature gas specific gravity and olefinic content.

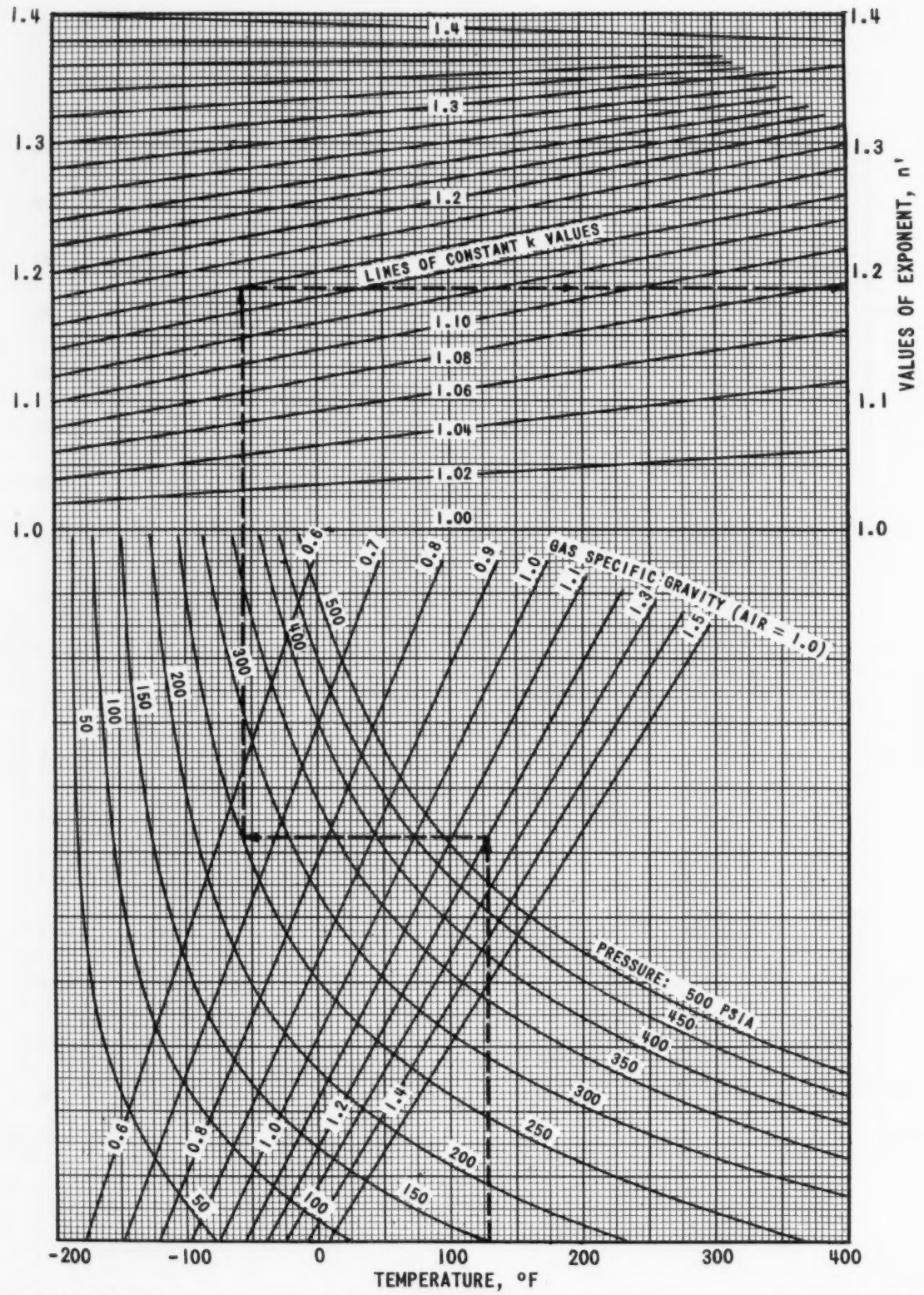


FIGURE 10.10—Isentropic temperature change exponent, n', as function of temperature, pressure, gas specific gravity, and heat capacity ratio.

isentropic work have been prepared and are included in this installment. Typical indicator cards for reciprocating compressors are included to illustrate the effect of clearance volume on the exponents for the compression and expansion parts of the cycle.

Exponent Charts for Some Gases. Charts giving the isentropic exponents, n′ and n, for eight gases were prepared from the generalized correlations (Figures 9.4 through 9.12) and ideal gas heat capacities (Tables 7.3 and 7.4).

TABLE 10.1—Sample Calculations of Isentropic Exponents for Hydrocarbons

Hydrocarbon	Temperature		Pressure		$C_p°$	k	Readings from Fig. 9.4–9.12		Exponents	
	Tr	t°F	psia	Pr			n′-k	n-k	n′	n
Ethane	0.8	−20	50	0.071	11.2	1.216	+0.013	−0.036	1.229	1.180
	0.8	−20	150	0.212	11.2	1.216	+0.046	−0.085	1.262	1.131
	0.9	+35	150	0.212	12.05	1.198	+0.026	−0.060	1.224	1.138
	0.9	+35	250	0.353	12.05	1.198	+0.017	−0.109	1.215	1.089
Propylene	0.9	131	150	0.225	16.42	1.138	0.030	−0.092	1.168	1.046
	0.9	131	250	0.375	16.42	1.138	0.056	−0.167	1.194	0.971
	1.0	197	150	0.225	17.78	1.126	0.021	−0.067	1.147	1.059
	1.0	197	250	0.375	17.78	1.126	0.037	−0.110	1.163	1.016
Isobutane	0.9	201	100	0.189	27.63	1.078	0.023	−0.100	1.101	0.978
	0.9	201	200	0.378	27.63	1.078	0.057	−0.257	1.135	0.821
	1.0	275	200	0.378	30.12	1.071	0.030	−0.16	1.101	0.911
	1.0	275	300	0.567	30.12	1.071	0.055	−0.24	1.126	0.831
Sulfur Dioxide	0.8	160	100	0.0876	9.94	1.25	0.013	−0.030	1.263	1.220
	0.8	160	200	0.1751	9.94	1.25	0.029	−0.064	1.279	1.186
	0.9	238	200	0.1751	10.28	1.24	0.017	−0.039	1.257	1.201
	0.9	238	300	0.2627	10.28	1.24	0.028	−0.060	1.268	1.180

TABLE 10.2—Sample Calculations of Isentropic Exponent for Natural Gas

Gas Specific Gravity	Pseudo Critical		Temperature		Pressure		Reference Value of (n′-k) at k = 1.1
	T_c °R	P_c psia	Tr	t°F	psia	P_r	
0.6	351	677	1.2	−39	200	0.296	0.0172
			1.2	−39	500	0.739	0.0464
			1.3	−4	200	0.296	0.0149
			1.3	−4	500	0.739	0.0385
0.7	388	670	1.0	−72	200	0.298	0.0290
			1.0	−72	500	0.746	0.085
			1.3	+44	200	0.298	0.015
			1.3	+44	500	0.746	0.0385
0.8	423	664	1.0	−37	200	0.301	0.0290
			1.0	−37	500	0.753	0.0864
			1.2	+47	200	0.301	0.0175
			1.2	+47	500	0.753	0.047
0.9	453.5	656	1.1	39	200	0.305	0.0218
			1.1	39	500	0.762	0.0602
			1.3	130	200	0.305	0.0152
			1.3	130	500	0.762	0.0389
1.0	481	650	1.0	21	200	0.308	0.0298
			1.0	21	500	0.769	0.0880
			1.2	117	200	0.308	0.0181
			1.2	117	500	0.769	0.0475
1.1	505	643	0.9	−6	100	0.156	0.0221
			0.9	−6	300	0.467	0.0834
			1.1	95	200	0.311	0.0223
			1.1	95	500	0.778	0.0610
1.2	526	636	0.9	13	100	0.157	0.0224
			0.9	13	300	0.472	0.0842
			1.1	118	200	0.315	0.0228
			1.1	118	500	0.786	0.0613
1.3	543	629	0.9	29	100	0.159	0.0228
			0.9	29	300	0.477	0.0858
			1.1	137	200	0.318	0.0231
			1.1	137	500	0.795	0.0618

The sample calculations in Table 10.1 illustrate the procedure used to obtain the points needed for preparing the exponent charts for the gases that are presented in Figures 10.1 through 10.8. Each chart has two pressure parameters, one for n′ and the other for n. The zero pressure line is the ideal gas condition where $n' = k = n$.

As can be seen on the charts, the temperature change exponent, n′, at higher pressures is greater than the gas state exponent; the volume change exponent, n, is less. For the higher boiling hydrocarbons, values of n are less than unity at the higher pressures.

For lighter gases, such as methane, where the value of k is relatively high, the spread of these two pressure parameters is less. This is shown on Figure 9.12 for a value of $k = 1.3$. The values of n and n′ are essentially equal to each other and to k when $k = 1.38$, as shown on Figures 9.13 and 9.14. For this reason, a specific chart was not prepared for methane.

At higher k values than 1.38, the order is reversed; and $n > k > n'$, as can be seen on Figures 9.13 and 9.14. For diatomic gases, such as H_2, N_2, and O_2, where $k = 1.4$, this "reversal" effect is very slight; and the assumption of $n = k = n'$ is justified. For monatomic gases, such as helium and argon, where $k = 1.67$, there is more difference between n′, k, and n, as can be seen on Figures 9.13 and 9.14.

For these monatomic and diatomic gases, the critical temperature is low, giving high values of T_r in most cases, at which ideal behavior is approached. For these reasons, it is usually satisfactory to assume $n = k = n'$ when $k > 1.38$.

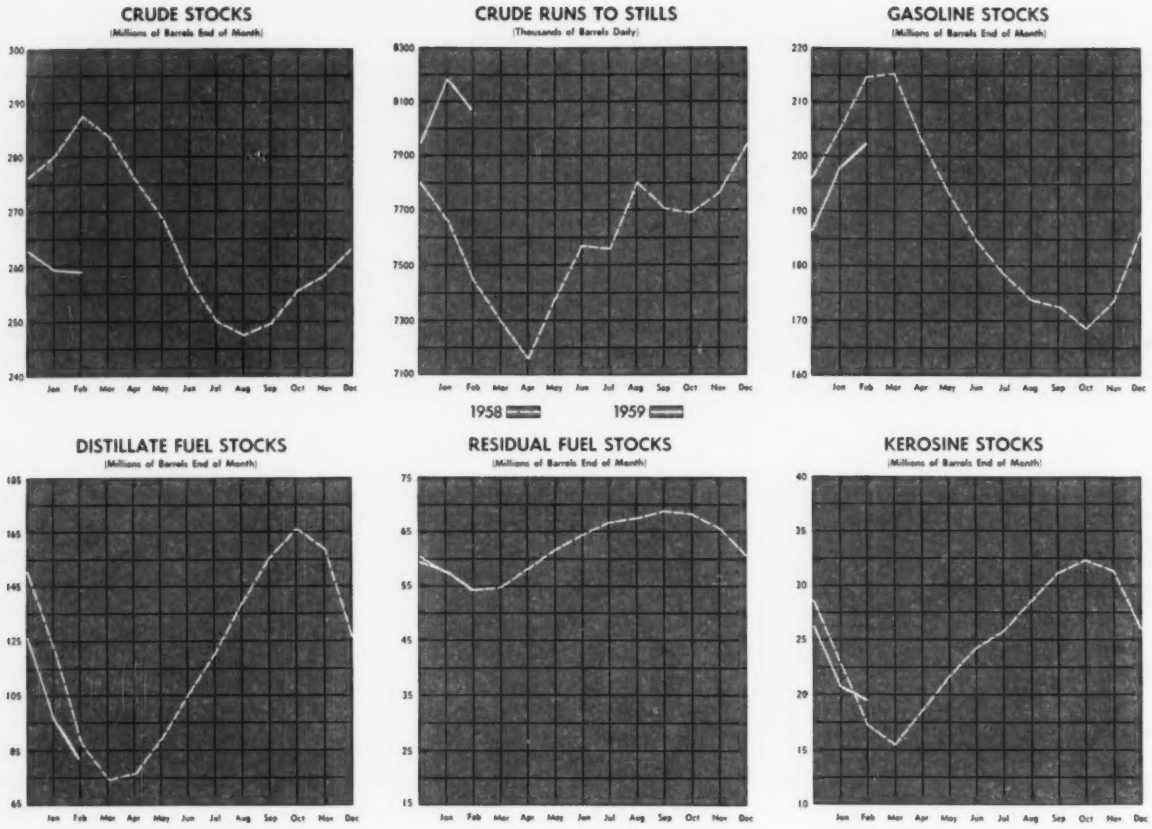
Charts for Natural Gases. Two charts, Figures 10.9 and 10.10, have been developed for estimating the isentropic exponent, n′, for hydrocarbon gases which are characterized by specific gravity (air = 1.0). Two separate charts are required because gravity and temperature alone do not define k.

Figure 10.9 gives k as a function of temperature, specific gravity, and percentage olefin. This was prepared from the $C_p°$ values given in Table 7.3.

Figure 10.10 is a three parameter chart giving n′ as a function of temperature, gas gravity, pressure, and k value. Figure 10.10 is similar to Figure 9.13 and was prepared from it by using average or pseudo critical conditions for hydrocarbon gases of different gravities. The top section of Figures 9.13 and 10.10 are the same, except for the range of n′ values. Figure 10.10 stops at $n' = 1.4$. The calculation of points used in plotting the lower part of Figure 10.10 is illustrated in Table 10.2. Values of the $(n' - k)$ difference at $k = 1.1$ were computed as this was the intermediate parameter (not shown) on Figure 9.13, making that generalization possible.

This involved correlating the reference $(n' - k)$ difference (lower part of Figure 10.10) and then making the conversion to all k values (top part of Figure 10.9).

PART 10B WILL APPEAR NEXT MONTH



Taking Stock

- Crude stocks leveling off
- Crude runs drop sharply
- All other stocks following seasonal trends

U.S. Petroleum Demand and Supply (Thous. Bbls. Daily)

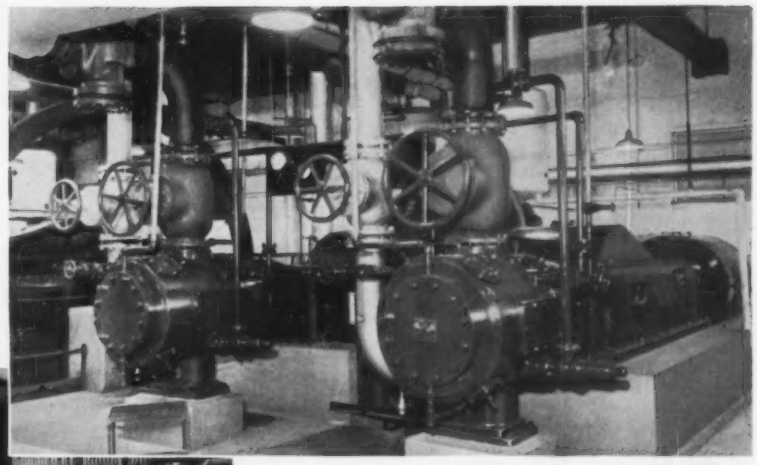
ITEM	February 1959	February 1958	February % Diff.	Jan. 1959	January-February 1959	January-February 1958	January-February % Diff.
DEMAND							
All Oils, Total Demand	10,664	10,557	+ 1.0	10,952	10,794	10,424	+ 3.5
Domestic Demand	10,414	10,278	+ 1.3	10,672	10,528	10,166	+ 3.6
Export Demand	250	278	—10.1	280	266	258	+ 3.1
Gasoline, Total Demand	3,641	3,487	+ 4.4	3,664	3,653	3,508	+ 4.1
Distillate, Total Demand	2,795	3,000	— 6.8	3,191	3,003	2,935	+ 2.3
Kerosine, Total Demand	467	594	—21.4	586	530	579	— 8.5
Residual, Total Demand	2,038	1,872	+ 8.9	1,960	1,997	1,873	+ 6.6
CHANGE IN STOCKS							
All Oils, Change in Stocks	—357	—1,324	....	—1,081	—717	—1,052	....
NEW SUPPLY							
Total New Supply	10,307	9,233	+11.6	9,871	10,077	9,233	+ 8.4
Domestic Production, Total	8,034	7,620	+ 5.4	7,947	7,988	7,651	+ 4.4
Crude Oil	7,194	6,809	+ 5.7	7,117	7,153	6,838	+ 4.6
Natural Gas Liquids	840	811	+ 3.6	830	835	813	+ 2.7
Imports, Total	2,273	1,613	+40.9	1,924	2,089	1,720	+21.5
Refined Products	1,273	783	+62.6	1,089	1,176	788	+49.2
Crude Oil, Total	1,000	830	+20.5	835	913	932	— 2.0
Crude, East Coast	748	684	+ 9.4	681	713	773	— 2.7
CRUDE RUNS							
Crude Runs to Stills	8,079	7,524	+ 7.4	8,190	8,137	7,601	+ 7.1
Domestic Crude	7,337	6,615	+10.9	7,211	7,270	6,670	+ 9.0
Foreign Crude	742	909	—18.4	979	867	932	— 7.0

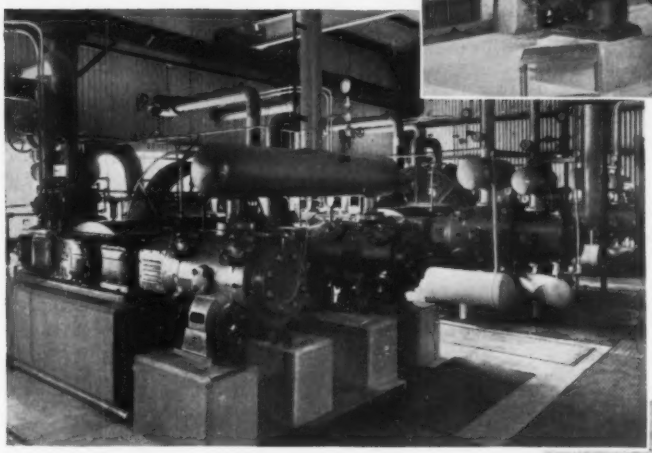
U.S. Stocks of Oils (Million Bbls. at End of Month)

KIND OF OIL	TOTAL IN U.S. Feb. 1959	TOTAL IN U.S. Feb. 1958	TOTAL IN U.S. % Diff.	TOTAL IN U.S. Jan. 1959	EAST OF CALIFORNIA Feb. 1959	EAST OF CALIFORNIA Feb. 1958	EAST OF CALIFORNIA % Diff.	EAST OF CALIFORNIA Jan. 1959
Crude Oil	259.1	285.0	— 9.1	259.7	219.3	240.4	— 8.8	220.9
Gasoline	207.5	215.9	— 3.9	198.0	178.8	187.0	— 4.4	171.5
Distillate Fuel Oil	81.3	87.9	— 7.5	95.4	70.6	73.8	— 4.3	83.8
Kerosine	19.4	17.2	+12.8	20.8	19.0	16.9	+12.4	20.5
Residual Fuel Oil	54.7	55.1	— 0.1	57.3	26.2	26.9	— 2.6	27.5

Sources: Except for latest two months, all data in above two tables are from U.S. Bureau of Mines. Last two months are based on American Petroleum Institute weekly reports, Bureau of Mines weekly crude stock reports, and WORLD OIL estimates.

SAVE with STEAM



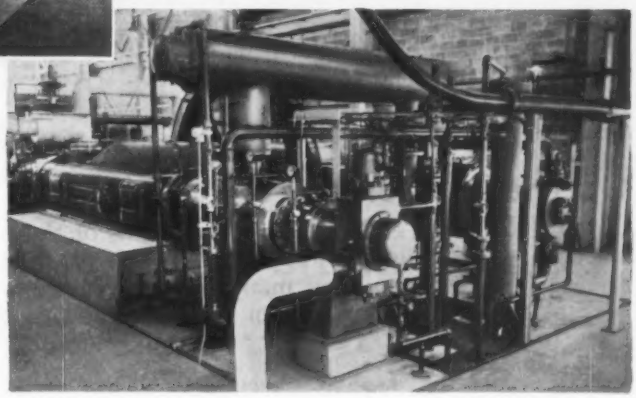


▲ **REFRIGERATION**

One of two Ingersoll-Rand XPV compressors handling ammonia for refrigeration in a large Midwestern plant. Two of these modern units are installed in the space formerly occupied by a single old-type compressor, and provide greater capacity with safer, more efficient operation and much less down time. Another XPV in the plant compresses air.

◀ **CATALYTIC CRACKING**

Three XPV compressors in a large refinery: in foreground is a single-stage unit handling flue gas; two 3-stage units in background compress inert gas. There are hundreds of XPV's on all refinery services, including hydrogen recyclers with "NL" non-lubricated compressor cylinders.



UREA MANUFACTURE ▶

This 860-hp XPV compresses carbon dioxide in four stages for the manufacture of urea. There are four XPV compressors in this chemical plant, including ammonia synthesis gas circulators.

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use its power with . . .

steam-driven compressors

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Dust-proof, leak-proof, fool-proof running gear— Completely sealed frame keeps dirt out, oil in. Full-floating precision aluminum bearings never need adjustment, so the unit may be kept sealed and on stream.

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Once again this month, PETROLEUM REFINER presents its quarterly compilation of refinery, natural gasoline, and petrochemical plant construction projects from all over the world. Keep pace with construction trends by reading "Construction Boxscore"—the most complete and up-to-date guide to building in the Industry.

Keep Going to Page 203

What's New

Every month PETROLEUM REFINER presents a section of the magazine devoted entirely to new equipment and literature which manufacturers have announced the previous month. You'll keep abreast of these new developments in the equipment field when you read this section every month.

Keep Going to Page 302

Up the Ladder

Yes, each month hundreds of the Industry's men go "up the ladder"—the promotion ladder, that is. New jobs are opened—old jobs are filled by new men, and you may know many of them. Take a look at "Men in Industry" to see what's happening to the men you know, and those you would like to know.

Keep Going to Page 273

The Key to Knowledge

Knowledge is the key to success, at least one of them. And what better way is there to gain the knowledge you need to advance than through a good book on a subject important in your part of the Industry. You can learn about some of the better books by reading this month's "New Books" section.

Keep Going to Page 271

"Rumors Can Hurt!"

Yes, any member of your company's management team will tell you that rumors are a continuing threat to any organization. In most companies the grapevine is built-in and will operate quite efficiently without regard for the truth of an item or its consequences. In many cases, however, a vicious word or half-truth can cost your company much money and ruin employe morale. For the complete story on how a rumor grows and what you can do to stop it, be sure to read "Rumors Can Hurt!"

Keep Going to Page 223

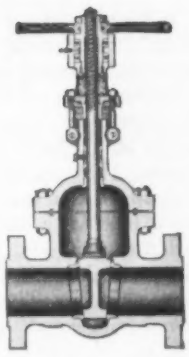
Replaced leaking valves with Crane gates No leaks...no maintenance...in 2 years

New gate valves, installed on steam lines to and from a fire-watch pump at a gasoline plant, leaked continually, almost from the day they were installed.

When frequent maintenance failed to stop the leaks, Crane steel wedge disc gates were installed. One valve was a 3-inch, 300-pound No. 33XR; the other one, a 4-inch, 150-pound No. 47XR—both rated for steam service at a maximum temperature of 850° F. Both valves have Exelloy discs and stems, and replaceable No. 49 Nickel Alloy, screwed-in body seat rings.

The switch to Crane valves was made two years ago. Since then, they have been in continuous operation. Not *one* leak has developed—and not *one* cent has been spent for maintenance.

Get the jump on your costly maintenance problems. Make original as well as replacement installations with Crane valves and other piping materials. For all facts about the many Crane valves used for refinery, pipeline and other services, see your Crane Representative or write to the address below.



Typical cross section of Crane steel wedge disc gate valves widely used in refinery, power and process services. Available in sizes up to 48 inches; for oil or oil vapor, steam, air, gas, gasoline, water and other services. In seven pressure classes—150-pound to 2500-pound, with temperatures to 1100°F. Choice of trim materials is most complete. Write for details.

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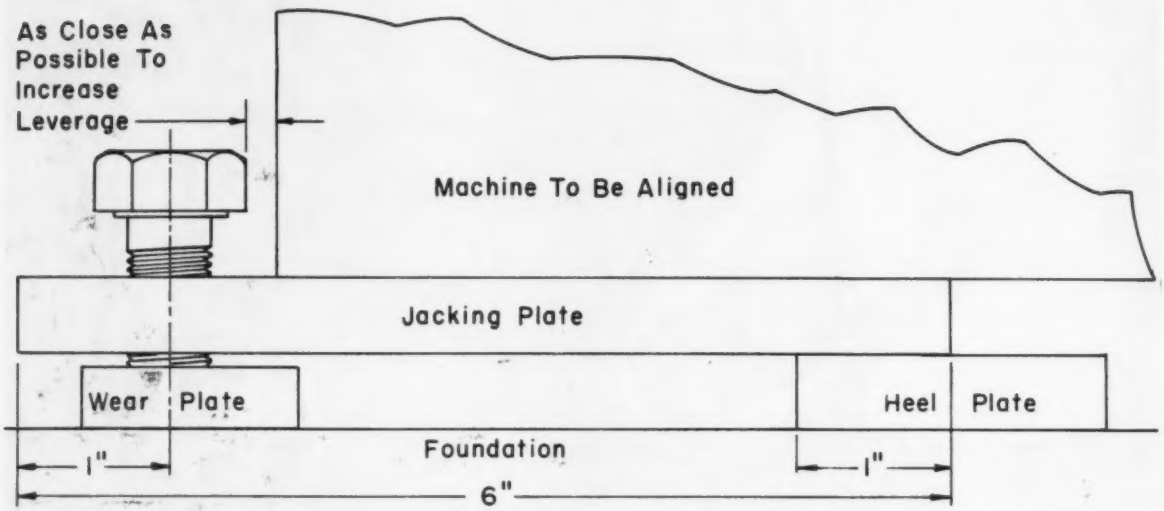
How to Do It...



Align Equipment With 'Jacking' Plates

Here's a method that is faster and surer than using wedges—and eliminates sudden elevation changes

A simple tool called a "jacking plate" can be made to level and align all types of stationary equipment.

When a piece of equipment is to be aligned and grouted, four of these plates should be made—one for each corner. They can be fabricated from 2 x 6-inch flat steel stock. Drill and tap a hole for a jackscrew about one inch from one end. The thickness of the plate depends on the weight of the equipment. The diameter of the hole should equal the plate thickness. Use an all-thread capscrew for the jackscrew.

The procedure for leveling and alignment is as follows:

When the foundation for the equipment is ready, the machine should be set on 2 x 4 planks on the foundation. This usually places the base line of the machine about ½-inch above the desired final elevation.

At each corner of the unit, place a jacking plate and a heel plate close to the foundation bolts. The heel plate must be of a thickness such that this thickness plus the jacking plate thickness brings the top surface of the jacking plate to the base elevation. A piece of scrap plate may be placed under the jackscrew as a wear plate.

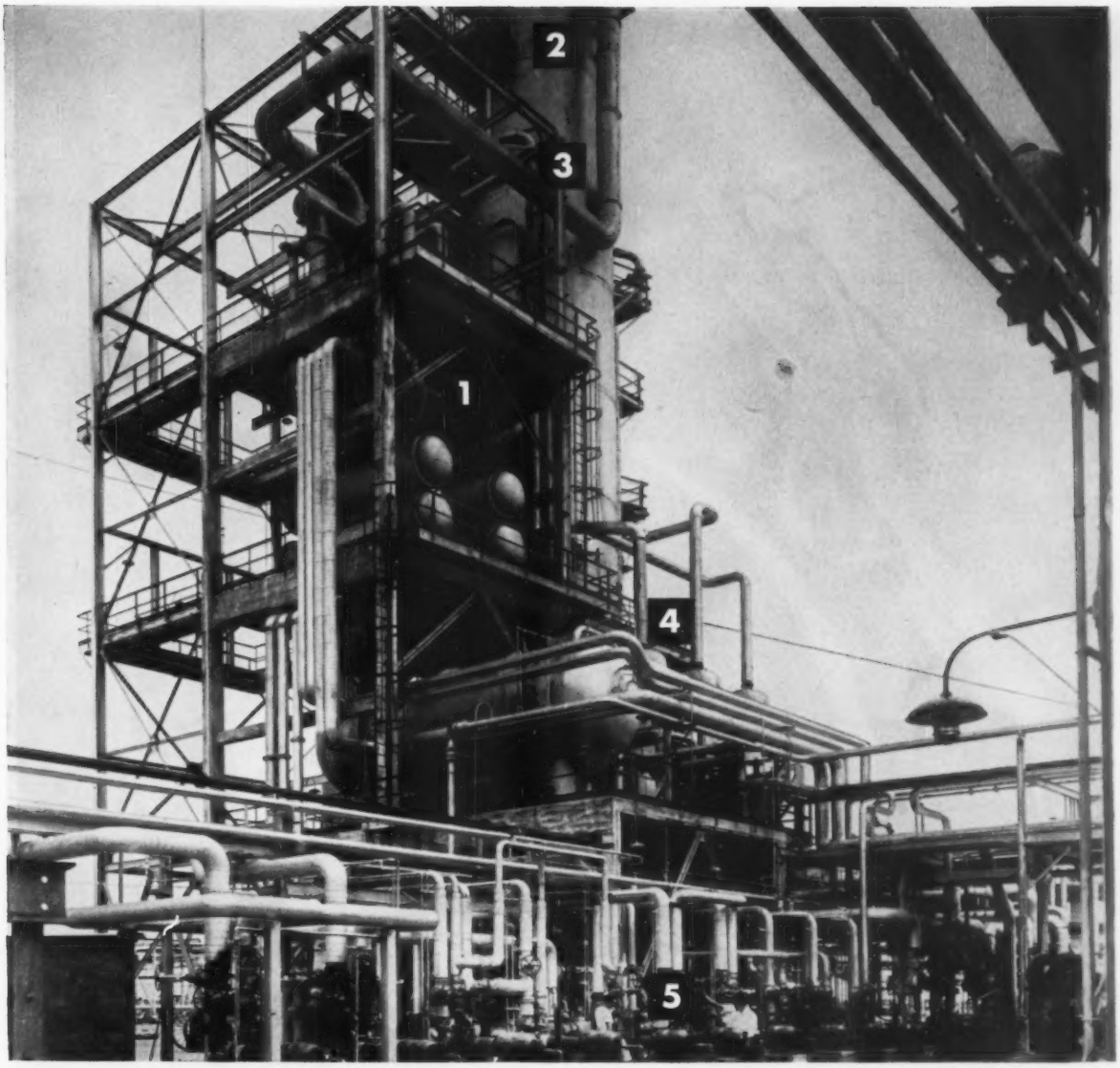
Screw down the jackscrews until the plates support the unit, and remove the 2 x 4's.

By adjusting the jacking screws and pulling down the foundation bolts accordingly, the unit may be brought to the proper elevation. Alignment is accomplished by bumping the unit into place. On heavy units, the jacking plates may be greased so that less effort is required.

The equipment is then grouted in. After the grout is set, the plates are easily removed by loosening the jackscrew and tapping to free the plates from the concrete.

This is a much faster and surer method than the one using wedges because adjustments of height accomplished by wedges are jerkey and hard to control, whereas, the use of jacking plates permits gradual, controlled adjustment.

When bumping a unit for alignment with wedges supporting it, the unit will change elevation. With jacking plates, the plates will be practically level providing two distinct advantages, (1) no elavation change while aligning and much easier sliding, (2) jacking plates are much eas-



5-point Monel "program" combats corrosion in Creole's 100,000 bbl crude unit

1. Atmospheric overhead condensers—Lukens Monel-clad steel on shell side.

2. Atmospheric tower – 20% Monel-clad on top head and top 11' 6" of shell.

3. Atmospheric tower– top 4 trays of Monel alloy.

4. Distillate drum – 20% Monel-clad throughout, nozzles Monel lined.

5. Pumps handling naphtha product and reflux—shafts of "K"* Monel age-hardenable nickel-copper alloy; impeller, lantern and case wearing rings and packing gland of "H"* Monel semi-hard cast alloy; impeller wearing ring of "S"* Monel hard grade cast alloy; Duraseal of Monel alloy.

Creole Petroleum Corporation at Amuay Bay, Venezuela . . . and Foster Wheeler Corporation of New York City . . . took full advantage of the corrosion-resisting properties of Monel* nickel-copper alloys at five trouble-spots to combat corrosion . . . corrosion from dilute mineral acids, by sulfur and naphthenic contents of the feed.

Monel alloy resists corrosion by aqueous solutions of hydrogen sulfide and hydrochloric acid. Chloride traces, which can cause corrosion, and particularly at temperatures below 300°F, can be handled with Monel alloy. This high nickel alloy resists wet carbon dioxide, too.

How can Monel alloy fit in your refinery's program to combat corrosion?

Contact us for help with your corrosion problems. No obligation.

*Registered trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N.Y.

INCO NICKEL ALLOYS

For more data on advertised products, use Readers' Service Cards, last page.

How to get a safer, clearer look inside at 500°F.

This peephole is giving you a look at what happens at 500°F.—through a PYREX brand Sight Glass. Even at high temperatures, you get a safer look, a *clear* look—because it's a *special* glass.

Glass that can stand up to abrasion, thermal or mechanical shock. Glass that can stand pressures up to 300 p.s.i. Glass that resists clouding and pitting from corrosives. Glass that stays transparent for a long service life.

You can use PYREX brand Sight Glasses to see into ovens, absorption columns, reaction kettles, furnaces, pressure vessels, evaporators, stills, or processing tanks. They're available in a range of sizes for all applications.

Ask your regular industrial supply dealer for more information—or write us for your copy of Bulletin EB-20. It gives complete specifications of PYREX brand Sight Glasses with mounting recommendations. Corning Glass Works, 14 Crystal Street, Corning, N. Y.

CORNING GLASS WORKS
CORNING MEANS RESEARCH IN GLASS

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ier to remove after grouting than are wedges.

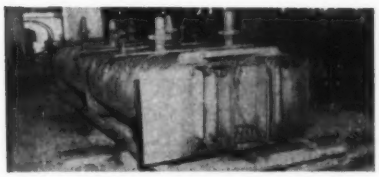
This idea was submitted by George Brengelmann, Lummus Construction Co., Woodbury, N. J.

Old Grease Cans Make Handy Shop Heater

Two grease cans welded together on an angle will make a handy shop heater. Set them on legs made of angle iron with runners along the sides to support the heater. Cut a hole in the front part of one of the cans and saddle weld the other one upright to enlarge the heating surface and provide a place for the stack.

For the burner, take a piece of 2-inch pipe and cut slots along one end and bend the orange peels down to a ⅜-inch nipple which has been blanked off on one end and a 1/16-inch hole drilled into the center. The slots serve for passage of air in the jet from the ⅜-inch nipple to make a blue flame in the heater. Place several fire bricks inside for flame impingement.

This idea was submitted by Harry Hess, Houston.



Pressure Operated Fuel And Lubricant Tanks

The fuel and lubricants for this refinery construction job are kept in pressure tanks to prevent contamination from dust or water. Each com-

INSULATION on towers, tanks and exchangers must be kept DRY. If moisture gets through, the efficiency drops.

Modern refinery and plant design places many major insulated vessels "in the open." You can maintain the efficiency of your insulation with easy-to-apply Laykold Weathercoat.

Weathercoat is a fibrated asphalt-base material of easy troweling consistency that dries to a black, remarkably tough and tenacious coating. A majority of the leading refineries are regular users of Weathercoat.

A new product: Mastic Weathercoat, a bodied material, for use wherever economy demands the application of a *single*, thick layer.

Write today for free illustrated brochure, entitled "Laykold Weathercoat for Insulation Protection."

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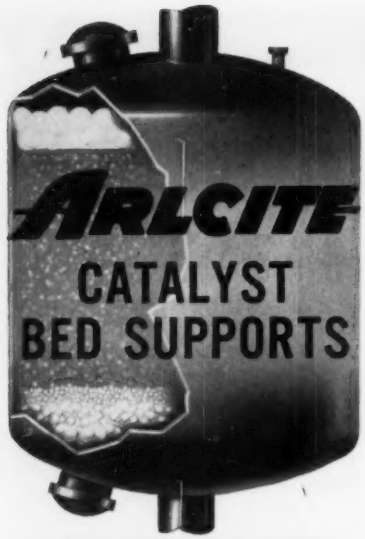


• CHEMICALLY INERT

• MECHANICALLY RUGGED

• RESISTANT TO THERMAL SHOCK

Scientifically compounded to "take it," Patterson Arlcite Spheres for fixed bed support and hold-down material in refining processes assure no contamination of valuable catalysts. Chemically inert and non-absorptive, these smooth-surface high alumina balls have highest resistance to thermal shock.

Arlcite Spheres offer the ultimate in mechanical strength—resistance to crushing, erosion and abrasion—and *maximum economy*, too. Field installations have extended over two years to date without replacement. Write us for the facts!

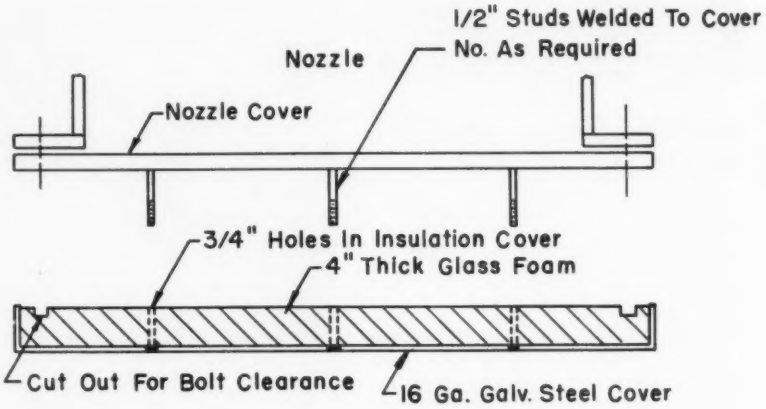
ARLCITE 86-8 Spheres are available in the following sizes: ¼", ⅜", ½", ¾", 1" and 1¼". Immediate shipment.

PORCELAIN DIVISION
FERRO CORPORATION
East Liverpool, Ohio

How To Do It . . .

partment has approximately 25 pounds of air pressure on the surface of the lubricant or fuel, and these are piped to their various consumption points around the job. The entire unit is filled at a bulk plant between moves and can be filled by tank trucks while on the job.

After the tanks have been mounted on the skids, the air is connected to the top of each section through a reducing regulator with its pop valve mounted on the side. The outlets are of ½-inch pipe and the cluster of valves shown at the front between the gage glasses is used to control the flow to each of the places where the fuel or lubricant is used. On engines, the lubricant is connected directly to the crank case, so that the proper level may be maintained by merely cracking a valve. When it is time to change oil, the old oil is drained and the new is replaced without the least chance of contamination. The same goes for fuel which is connected directly to the injector systems of the diesel engines. On shafts where sight feed lubricators are used, the tank is connected to the top of the lubricator with copper tubing.



Nozzle Covers Need Not Be Reinsulated

Manhole covers, large nozzles or irregular heads which are insulated and have to be removed with some degree of frequency present a repetitive cost problem for reinsulation. A technique of installation is shown in the figure. This particular insulation was installed on the head end, evaporator section of a refrigeration machine.

The insulation is placed inside a light-gage steel cover and cemented in place. Studs welded to the nozzle cover are long enough to protrude through the insulation and light-gage cover and are bolted to retain the insulation on the manhole cover. When the nozzle has to be opened, the bolts on the studs are removed and the entire insulated section is removed (insulation and cover). When the manhole cover is replaced, the insulated section can be fitted over the studs and rebolted in place without going through costly reinsulating procedures.

This idea was submitted by Max S. Bass, Heyden Newport Chemical Corp., Garfield, N. J.

$$ Your Ideas Are Valuable! $$

At least $10.00 will be paid for each idea accepted for "How To Do It." All you need to do is write a brief note telling about your idea, then attach a photo or sketch (if needed), and mail it to Editor, Petroleum Refiner, P. O. Box 2608, Houston.

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here's how to specify

DEKORON INSTRUMENT HARNESS

to fit your requirements exactly

ALUMINUM OR COPPER / POLYETHYLENE OR NYLON + plastic sheath = DEKORON METL-COR / DEKORON POLY-COR — **FOR CORROSION RESISTANCE**

DEKORON METL-COR / DEKORON POLY-COR + steel armor = ARMORED METL-COR / ARMORED POLY-COR — **FOR IMPACT AND CORROSION RESISTANCE**

ARMORED METL-COR / ARMORED POLY-COR + plastic sheath = ARMORED METL-COR, Plastic Overall / ARMORED POLY-COR, Plastic Overall — **FOR IMPACT AND MAXIMUM CORROSION RESISTANCE**

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No matter what your special environmental requirements for instrument tubing may be—no matter how stringent for corrosion, impact or fire resistance—there's a type of Dekoron instrument line harness to *satisfy them exactly*. In most cases you can get *delivery from stock*. And *all* Dekoron products have three things in common: Highest quality materials and construction . . . lowest possible installation cost . . . longest life of any instrument line harness. That's *Dekoron—America's Premier Instrument Tubing Line.*

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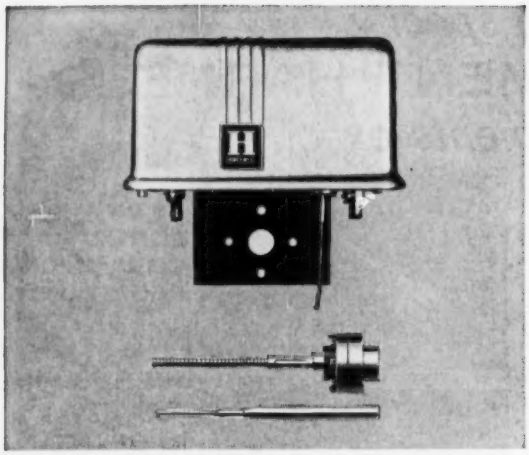
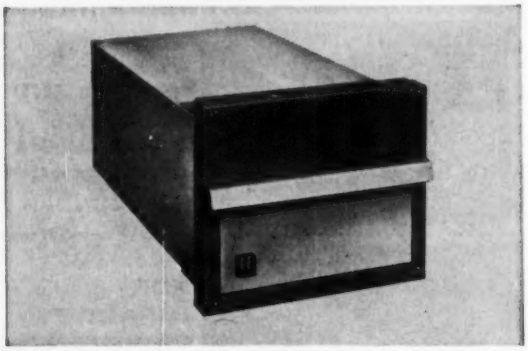
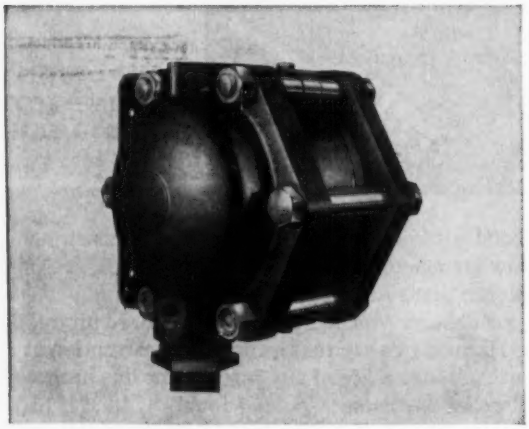


***TEL-O-SET* TRANSMITTER** converts quickly from temperature to pressure service. Equally accurate at small spans of 20 psi and 50 F or at wide spans of 150 psi and 400 F. Range fully adjustable without adding or changing parts.

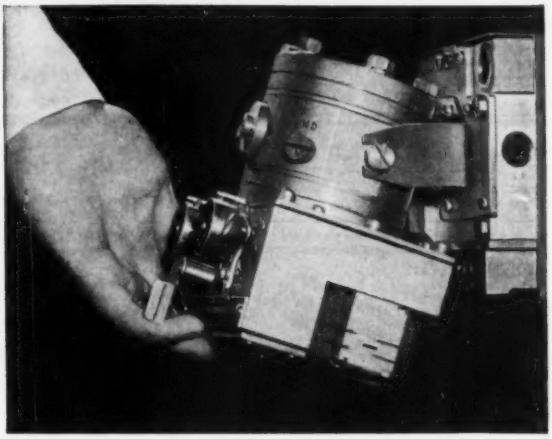


***TEL-O-SET* MV/P TRANSMITTER** for temperature measurement, converts any millivolt signal to a standard 3-15 psi pneumatic signal.



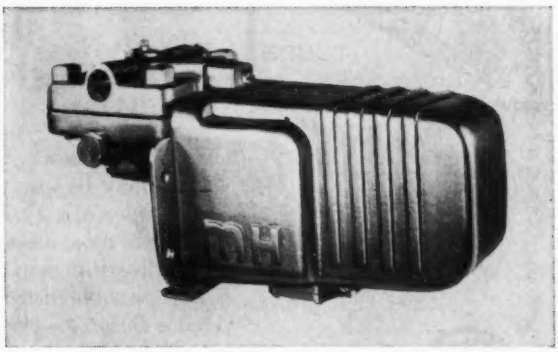
BELLOWS FLOW METER is ideally suited to fuel flow metering, unequalled for accuracy, stability and versatility. Convenience features include fast range changing in field, quick calibration and adjustment, easy cleaning and servicing.

***TEL-O-SET* CONTROLLER** is conveniently mounted on back of instrument case, has quick-connect switch permitting both fast mounting and easy removal of the unit while process remains on control. The control unit can be separately mounted in any remote location if process demand requires.

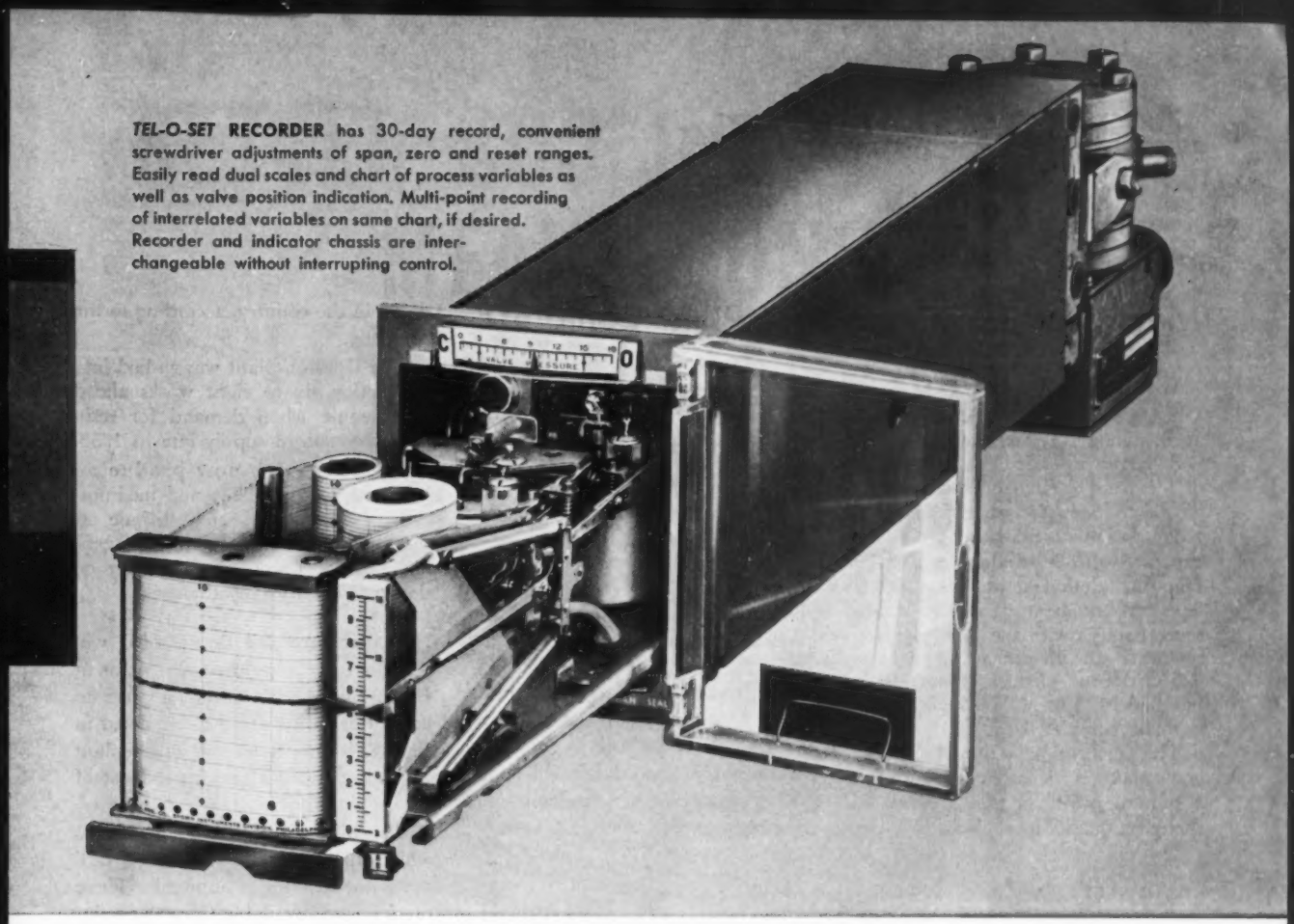


Control...

with advanced



DIFFERENTIAL CONVERTER transmitter offers many advantages in low pressure air flow applications. Mercuryless, it's accurate within ± ½% of full scale. Range continually adjustable in field. Excellent sensitivity obtained over distances as great as 1,000 feet.



***TEL-O-SET* RECORDER** has 30-day record, convenient screwdriver adjustments of span, zero and reset ranges. Easily read dual scales and chart of process variables as well as valve position indication. Multi-point recording of interrelated variables on same chart, if desired. Recorder and indicator chassis are interchangeable without interrupting control.

every process variable...
TEL-O-SET miniature instruments

Simplify control of your process, and gain the extra savings that come with *Tel-O-Set* miniature pneumatic instruments. The same instrument can be used to record, indicate and control virtually any variable—temperature, pressure, flow, fuel-air ratio.

This interchangeability means important economy for you: Process operations can be changed without obsoleting your instruments. Personnel training time is minimized. Parts inventory is kept low.

Tel-O-Set instruments are accurate, sensitive, have true linear calibration, and respond swiftly to process changes. No miniature pneumatic instrument can match them for ease and economy of maintenance.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

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First in Control

Who's Building...

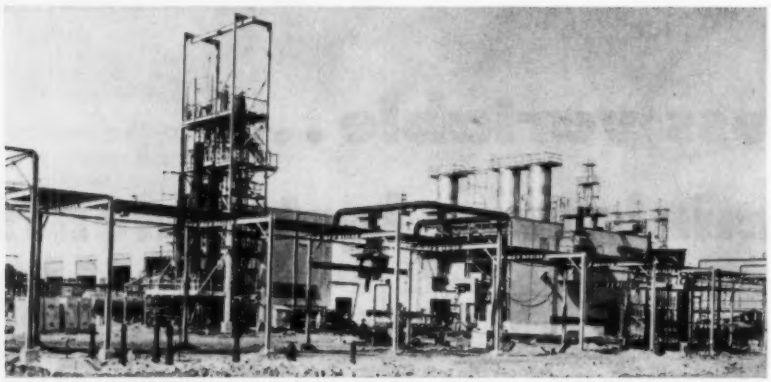
Magnolia's New Ethylene Plant Complete

With the completion of Magnolia Oil Co.'s high-purity ethylene plant at Beaumont, Texas, the Gulf Coast will have expended its last source of inexpensive ethylene raw material. To be the world's largest plant of its type, the unit will have an annual capacity of 380 million pounds of high-purity ethylene as well as propylene and butadiene. It will be built in several stages with the first stage representing an investment of at least $25 million. Construction to be handled by The M. W. Kellogg Co., is to be completed in 1961.

The purification section of the ethylene plant is designed to ensure a minimum purity of 99.8 percent although a quality level above 99.9 percent is expected. Trace impurities will be removed to ultimate practicable limits so that the ethylene can be used in any known polymerization or other conversion process.

Magnolia's Beaumont refinery was chosen as the site chiefly because of the ready availability of waste refinery gases as raw material for the plant and the large concentration of ethylene consumers in the Gulf Coast area.

The new plant has been under study for several years, and is the first of a number of projects by which the Mobil Oil Co. organization will supply greater quantities of petroleum-based chemicals to the chemical industry.



This is the gas-processing area of U.S.I.'s Houston polyethylene plant.

U. S. I.'s Houston Plant Starts Production

U. S. Industrial Chemical Co.'s new polyethylene plant at Houston has just started production and is already shipping in commercial quantities. The plant will soon be producing polyethylene resins at 75 million pounds annually. U.S.I. plans future expansion to double the plant's capacity and bring production to 150 million pounds of high-pressure polyethylene per year. This is expected to be completed by the third quarter of 1960.

U.S.I. annual production from its Tuscola, Ill., plant is about 100 million pounds. Thus the new Houston plant boosts the company's polyethylene production to 175 million pounds annually, and the new expansion will give U.S.I. a total capacity of 250 million pounds of high-pressure polyethylene per year. This capacity will make it the second largest polyethylene producer in the country, according to the company.

The Houston plant was rushed into production six to eight weeks ahead of schedule when demand for resin began to outrun supply late in 1958.

The company is now producing low-density (.915-.924) and medium-density (.925-.929) polyethylene at the Houston unit. However, the company has also worked extensively on the high-density polyethylenes.

The Standard Oil Co. (Ohio) will build a new acrylonitrile plant at Lima, Ohio, with construction to begin this spring and be completed in 1960. The multi-million dollar plant will make Sohio a major producer of the product.

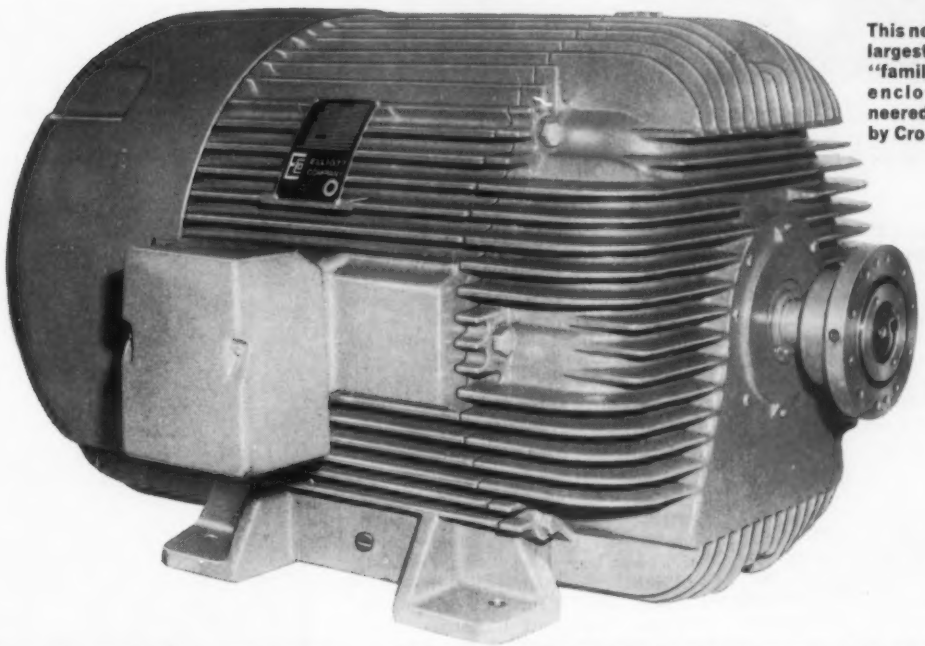
The plant will employ a process which upgrades propylene, using substantial quantities of ammonia. These products are available from the refinery and ammonia plant adjacent to the new plant site. Sohio's new process is said to considerably reduce the number of manufacturing steps between the basic raw materials and acrylonitrile.

The acrylonitrile produced by this route is fiber grade. It does not have any of the major impurities which are typical of the acetylene or ethylene routes.

The process involves catalytic, vapor phases reactions, and is highly selective. However, Sohio expects to recover commercial quantities of acetonitrile as a by-product, for which it expects to develop new markets. Present markets for this material are somewhat restricted in character. Market studies indicate that appreciably greater quantities could be sold at prices lower than the present 45¢ a pound. Highly promising applications are in the separation of olefins; as a special solvent in a number of specific fields; as a reaction agent and medium; and as a chemical raw material.

Construction of the Lima plant will be handled by Badger Manufacturing Co.

BETTER COOLING MEANS LONGER LIFE LESS MAINTENANCE



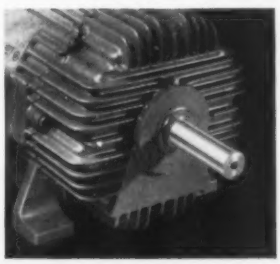
This new 300-hp unit is the largest of the Elliott C-W "family" of ribbed-frame enclosed motors, pioneered in the United States by Crocker-Wheeler.

ELLIOTT C-W SEALEDPOWER MOTORS

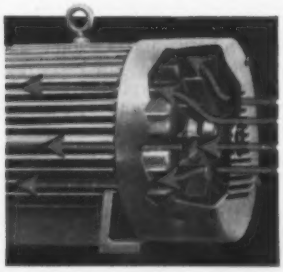
The numerous thin, deep ribs of Elliott C-W SEALEDPOWER Motors are the most advanced development of the ribbed construction, pioneered in the United States by Crocker-Wheeler. Modifications of SEALEDPOWER totally-enclosed fan-cooled motors include explosion-proof designs in all ratings up to 300 hp. Either open greasable or pre-lubricated bearings can be furnished.

Highly-effective sealing prevents entrance of moisture, dust, dirt, corrosive materials; consequently these motors can be depended upon for long, trouble-free service.

In numerous cases, SEALEDPOWER motors are proving to be more economical than standard open motors because of their low maintenance and dependability.



Extra fins keep bearing cool. This potential trouble spot is effectively cooled by the generous extra fins seen in the photograph above.



Cooling blast hugs frame. Air is directed along fins extending entire motor length. Easy to clean — no enclosed cooling passages to clog up.

ELLIOTT Company

CROCKER-WHEELER PLANT JEANNETTE, PA.

Newest data on modern enclosed motors—including explosion-proof—is given in Elliott Bulletin PB 6000-2. Send for free copy today.

W9-2

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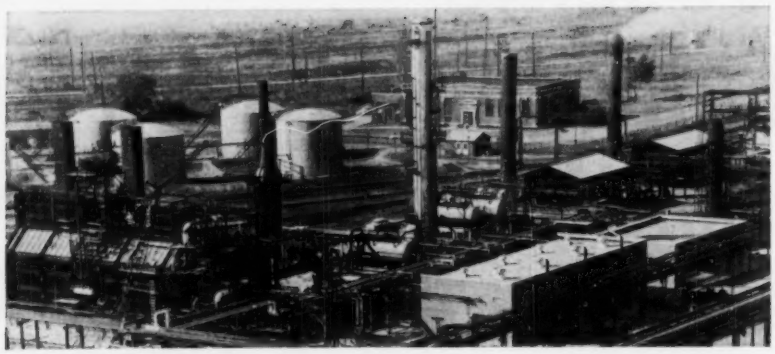
Building . . .



The new catalytic reformer at Cities Service Oil Co.'s East Chicago, Ind., refinery is being placed on stream. It will process 7,500 bpd of straight-run gasoline into high-octane material. Included in the new unit is a sulfuric acid feed treater.

Monsanto Chemical Co. will be partial owner of a chemical plant to be built at Istanbul, Turkey. Other owners are Vinylex, Ltd., Sirketi, a private Turkish trading and manufacturing company; and the Italian firms Sicedison, S.P.A., and Oranzio de Nora. The project will be financed through a $6.1-million loan from the U. Development Loan Fund, and will produce polyvinyl chloride resins, caustic soda, calcium carbide and related chemicals.

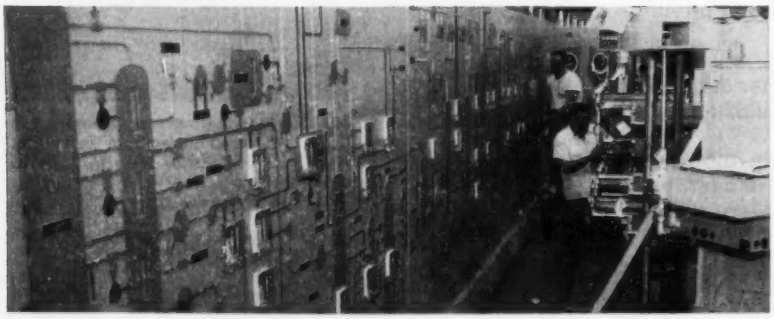
Cuba plans to move a 2,000-bpd refinery at Cabaiguan due West to the Caribbean port of Cienfuegos. Capacity of the $4-million plant will be increased to 4,000-5,000 bpd, according to the Cienfuegos Association of Merchants and Manufacturers.

Petroleo Brazileiro is planning an expansion at its Mataripe refinery, near Salvador, Bahia, Brazil. Included will be two crude distillation units, to be created from existing thermal cracking units; atmospheric and vacuum distillation units; catalytic cracking, propane deasphalting and phenol solvent extraction units, and lube and wax processing units.

Standard Vacuum Oil Co.'s Bombay, India, refinery has its new $2-million asphalt plant in the final stages of construction. The 125,000-long-ton-per-year plant is scheduled for completion in June. More than 90 percent of the production will be paving asphalt, and the remainder in "cut backs." Primary process units are an oxidizer tower, vacuum flash tar tower and a furnace to heat bottoms from the combination fractionator.

Continental Oil Co. plans to build a portable-type natural gasoline plant on its Ramsey lease near Pecos, Texas. The 5-MMcf-per-day plant will cost $430,000, and plans call for further expansion later this year. Southwest Industries, Inc., is handling construction.

Ente Nazionale Idrocarburi and Societe Financiere Italo-Suisse, Geneva, will form a new company to build a refinery in Switzerland and a pipeline from Italy. The firm will operate on a 50-50 basis. The proposed 40,000-bpd refinery will go up at Aigle, Switzerland, and be fed by a line from Genoa, Italy.

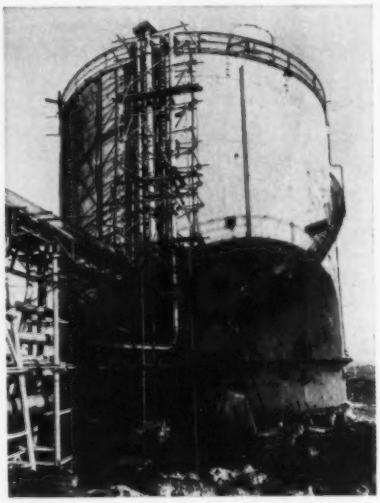


Petreleo Brasileiro's Mataribe refinery near Salvador, state of Bahai, Brazil, will be directed from a 168-foot graphic panel. One of its 24 units is shown being assembled by Minneapolis-Honeywell Regulator Co..

Polymer Corp., Ltd. plans to build a synthetic rubber pilot plant at Sarnia, Ont., Canada. The Curran and Herridge Construction Co., Ltd. will handle construction.

Texas Gulf Sulphur Co. and Devon-Palmer Oils, Ltd. are jointly constructing a new sour gas recovery plant at Okotoks, near Calgary, Alb. It is expected to come on stream this Summer with an annual capacity of 100,000 tons. Texas Gulf will be the operator.

Gulf Oil Corp. is stepping up plans to build a 50,000-bpd, $100-million refinery near Charleston, S. C., on a 3,000-acre site purchased by the company two years ago. The company says it needs a plant on the East Coast to process oil from its foreign reserves. Completion of the project is planned within three years.



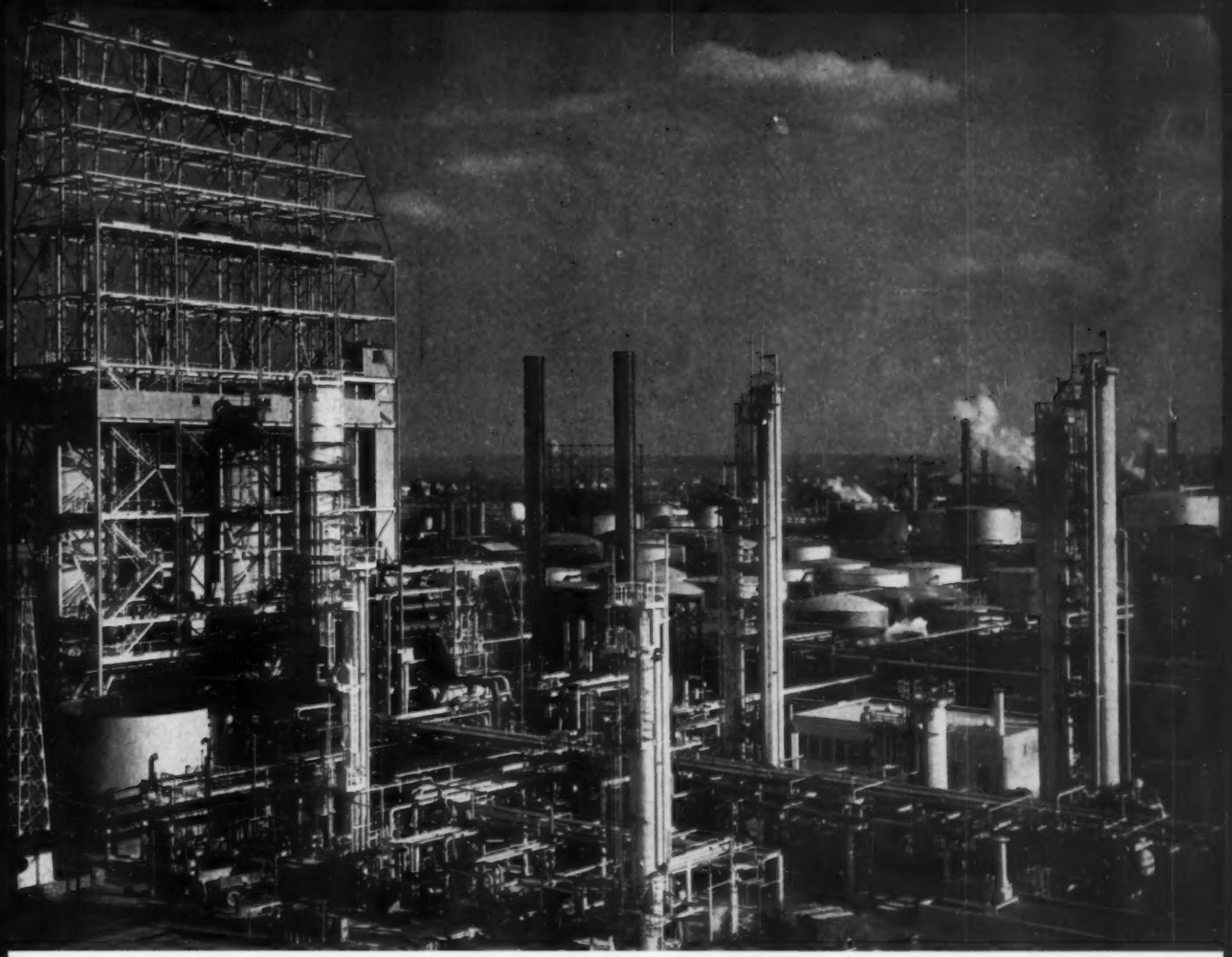
North Thames Gas Board, England, has installed this 90,000-cubic-foot insulated aluminum tank—one of Great Britain's largest. Constructed of fully radiographed aluminum, it will store liquid methane at —260 F.

E. I. duPont de Nemours & Co. plans to build an acrylic fiber plant at Dorbrecht, Netherlands, later this year. It will produce 15-million pounds annually, and will be Du Pont's first European textile fiber plant.

Witco Chemical Co. is planning a $56-million Argentine petrochemical complex along with Fish International Corp. and Argentine interests. Each group will finance one-third of the project.

Caribbean Chemical and Fertilizer Co. is planning to build a $15-million anhydrous ammonia and urea plant at Freeport, Bahama Islands. The installation will include a 100-ton-per-day am-

For more data on advertised products, use Readers' Service Cards, last page.



19,000 B/D COKER ON STREAM FOR MOBIL OIL CO.*

*A Division of Socony Mobil Oil Company, Inc.

unit feeds mixture of 7 stocks including Furfural Extract, Duosol Tar and Propane Deasphalting Tar

The new 19,000 B/D Delayed Coking Unit – designed, engineered and constructed by The Lummus Company for Mobil Oil Company at their Paulsboro, New Jersey refinery – is on its initial run.

The coker, comprising 4 coke drums 19 feet in diameter by 63 feet tangent to tangent, is designed for 764 tons per day of coke, making it the largest initial capacity coker ever built in the United States.

The feedstocks are various reduced crudes or blends of residua whose gravity varies from 3 to 14° A.P.I. These charge stocks may be blended with up to 25% of furfural extract.

The unit cokes the heavy residual stocks withdrawn from other refinery units which previously were blended into fuel oil. The coker makes seven products: fuel gas, butane-butylenes, light and heavy gasolines, light and heavy gas oils, and coke.

In addition to the coking section, the unit includes: a gas recovery section, sulfuric acid treater for gasoline, amine treater for light hydrocarbons, and a caustic treater for the butane-butylene stream.

* * *

The Mobil Oil Coker is the 13th delayed coking unit engineered and constructed by Lummus. Lummus has built over 40% of the total delayed coking capacity erected in the last 10 years in the U.S.

When you plan a new unit – or a complete refinery – Lummus can put over 50 years of experience, on more than 800 plants throughout the world, to work for you.

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY THROUGHOUT THE WORLD

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Visit The Lummus Exhibit, Fifth World Petroleum Congress Exposition, New York Coliseum, June 1-5, 1959

WE DELIVER

We know you have money in mind when you talk about buying catalysts.

We know you think of profit, as well as price. We certainly agree that there may not be much difference, pricewise or otherwise, between one company's catalyst and another's. But there *is* a difference in what you get when you buy it. And when *this* difference shows, it shows in your profits.

That's why—when you are considering the purchase of one of our catalysts—we make our experience in industry and in pioneering and perfecting catalysts and catalytic processes available to you. You have our full assistance in selecting the *one* catalyst from our many grades which will make the *most money* for you.

And when you select a catalyst we manufacture, we evaluate its performance and offer our application knowledge to see that it is *delivering what you want* . . . maximum efficiency, maximum profit.

*HOUDRY PROCESS CORPORATION
1528 Walnut Street, Philadelphia 2, Pa.
*Houdry means Progress . . . through Catalysis

Building . . .

monia unit using heavy oil as a source of synthesis hydrogen, and a urea unit of the full-recycle type designed for 54,000 tons annually. Urea will be produced in prilled form suitable for fertilizers, feed supplements and industrial purposes.

Industrias Plasticas Argentinas Koppers, S.A., (IPAK), plans to build a styrene monomer plant near Buenos Aires, Argentina. It will have a capacity of 15,000 metric tons per year and will cost $7.5 million. The company also plans to build a $16-million ethylene and polyethylene plant near Buenos Aires, slated for completion in 1961.

The new styrene plant will supply raw material for the polystyrene plastics plants already operating in Argentina, and will eliminate expenditures for foreign exchange. It also will have capacity to supply styrene monomer for Argentina's synthetic rubber industry.

Carter Oil Co. is planning an asphalt emulsification unit and revamp of the road-oil plant at its Billings, Mont., refinery. To be built by The Refinery Engineering Co., capacity of the new asphalt plant will be about 7,000 gallons per hour of emulsified asphalt in both rapid and low-set grades for use in road construction. The jobs are part of an extensive building program under way at the refinery. Other projects include a 2,300-bpd alkylation unit, a light-ends debutanizer and revamp of a 9,220-bpd bauxite desulfurizer into a 10,275-bpd naphtha hydrofiner. The bulk of construction will be finished early in the third quarter, 1959.

Montecatini Co. has begun construction of its $90-million Brindisi, Italy, petrochemical plant, the country's largest. With a planned capacity of 700,000 metric tons of chemicals per year, the plant will be the largest in the Montecatini group for processing hydrocarbons. It will produce several plastics, including polyethylene, and isotactic polypropylene, polymers for synthetic fibers, aldehydes, alcohols and organic solvents. Production will be a minimum of 1.3-million metric tons of raw materials annually. Estimated completion time is three years.

Humble Oil & Refining Co. has contracted for design and construction of its King Ranch gas plant with Hudson Engineering Corp., Houston. To be located 14 miles southwest of Kingsville, the plant will recover approximately 28,000 bpd of liquid products when processing 800 MMcf of gas per day. Field construction will begin soon, with completion planned for 1960. However, a portion will be on stream in late 1959.

This is the last phase of Humble's $70-million Southwest Texas area gas

For more data on advertised products, use Readers' Service Cards, last page.

Tidewater's "Refinery of the Future" uses 8,500 tons of USS National Seamless

TIDEWATER OIL COMPANY'S DELAWARE REFINERY, south of Wilmington, Delaware, is the site of the world's largest Orthoflow fluid catalytic cracking unit—a result of the revolutionary concept of using single, large-capacity units rather than multiple ones for each process in the refining operation. The purpose is to save costs—both in initial investment and maintenance.

National Seamless Tubular Products—over 8,500 tons and in sizes from 2⅜" to 24" O.D.—is an integral part of the 250 miles of oil-carrying pipelines which criss-cross this gigantic operation.

We make it our business to keep abreast of developments in petroleum refining, because we specialize in solving refinery tubing problems. In fact, we make 24 different steel tube analyses, each one *specifically developed* to combat refinery conditions such as corrosion, oxidation or pressure. Other chemical compositions are available in tubular products, and many temperature problems are presently being studied.

To make sure you get the right alloy to meet your requirements, we have a Mill Service Force technically trained to assist you. This Force is available for consultation in the field. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS and National are registered trademarks

Here are National Tube's two dozen different tube analyses:

Carbon	5 Cr, ½ Mo	17 Cr
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8
1 Cr, ½ Mo	7 Cr, ½ Mo	18-8 Ti
1¼ Cr, ½ Mo	8 Cr, ½ Mo	18-8 Cb
2 Cr, ½ Mo	8 Cr, 1 Mo	18-8 Mo
2¼ Cr, 1 Mo	9 Cr, 1 Mo	25-20
2½ Cr, ½ Mo, ¾ Si	12 Cr	3½ Ni
3 Cr, 1 Mo	12 Cr, Al	5 Ni

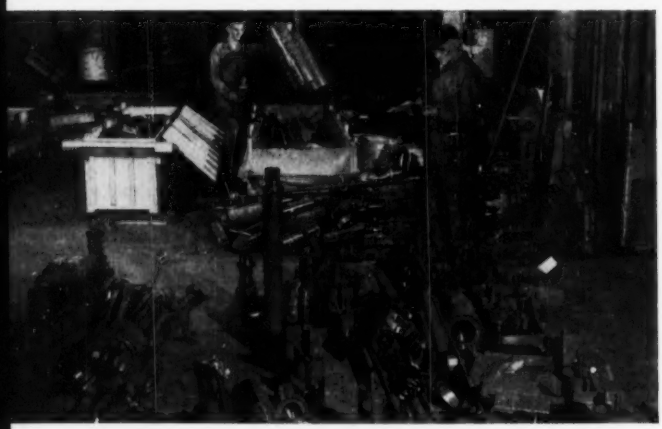
National Tube Division of USS United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Supply Division, Warehouse Distributors • United States Steel Export Company, New York

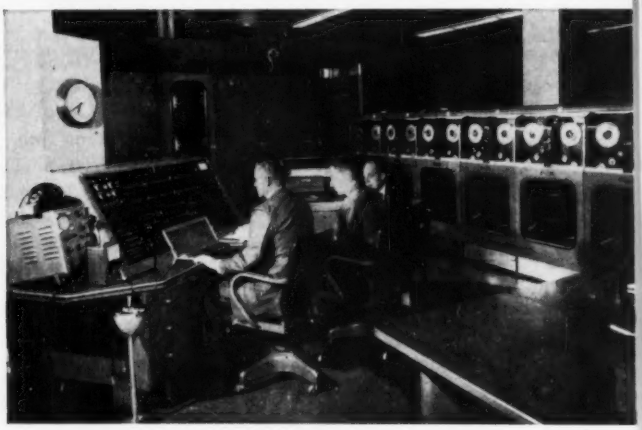
How Blaw-Knox cuts your power piping costs

121,000 square feet of space at your service. Power piping facilities at Pittsburgh include 56,000 square feet of plant area and an additional 65,000 square feet for exterior storage. An additional new plant is located on a 15-acre site in Jackson, Mississippi.

Your job is under the personal supervision of an experienced engineer, who follows your project from beginning to end. Your piping is handled with the most modern equipment for welding, heat treating, and bending. Fabricating techniques, proven by rigid testing, are used.



New product development. Blaw-Knox developed an enclosed type of functional spring hanger as part of their complete line of hangers for supporting any piping system. Here a group of hangers individually designed for a project is factory checked to assure fast field erection.



Stress calculation cut from months to a day . . . with pace-setting engineering. An exclusive Blaw-Knox method uses an electronic computer for automatic computation with no limitation on the complexity of system. Full accuracy, with tremendous savings in time and cost. Write for details.

BLAW-KNOX

BLAW-KNOX COMPANY
Power Piping Division
829 Beaver Avenue, Pittsburgh 33, Pennsylvania

Building . . .

project, which includes gas lines extending into several oil and gas fields, the main gas processing and cycling plant, and the 238-mile 30-inch pipeline from the plant to Houston.

Nevis Operators' Committee has awarded The Fluor Corp. of Canada, Ltd., a $3-million contract to engineer and construct a gas processing plant at Nevis, Alb. This will be the first major gas treating plant in the Nevis field. When completed in November, it will yield 43-MMcf of gas and 125 long tons of sulfur per day. Construction will begin this month.

The Texas Co. has started construction of a sulfuric-acid-type alkylation unit at its El Paso, Texas, refinery. It will have a capacity of 1,600 bpd of high octane alkylate, which will upgrade gasoline. The site has been cleared and contracts awarded for much of the construction. Completion is scheduled for late 1959.

General Petroleum Corp. has awarded a contract to Bechtel Corp. to build a new delayed coking unit for its refinery at Torrance, Calif. It has a planned throughput of 9,300 bpd and will increase the refinery's coking capacity to 35,000 bpd. Construction will begin soon, with completion slated for the first quarter of 1960. The unit will cost upwards of $4.5 million.

AviSun Corp., a new company formed by Sun Oil Co. and American Viscose Corp., has leased linear polyethylene facilities of Koppers Co., Inc., at Port Reading, N. J. One line of this plant is being modified for polypropylene production using a Sun process to be operated by Koppers under AviSun's technical direction. The 10,000-ton-per-year converted plant is expected to be at full production by mid-1959.

Petroleos Mexicanos has been granted $15 million in credit for construction of three proposed anhydrous ammonia plants. The company is reportedly talking with The Foster Wheeler Corp., Fluor Corp., and Arthur G. McKee Co. about possible engineering contracts.

Sun Oil Co. has begun construction of a $100,000 product control center at its Marcus Hook, Pa., refinery. It will collect plant operating data and monitor continuously the quality variances in important characteristics of product streams. It will be located at a 60,000-bpd refinery unit which includes catalytic cracking, crude and vacuum distillation, visbreaking and gas processing operations. Information will be gathered by viscometers, continuous chromatographs, boiling range recorders, density trans-

OUTSELLS THEM ALL!

HERE'S WHY

1 2½ to 1 ratio – guide length to guide diameter–prevents galling and hanging up.

2 High thermal expansion rate of sleeve guide and low thermal expansion rate of hardened stem retainer eliminates binding and galling even at elevated temperatures.

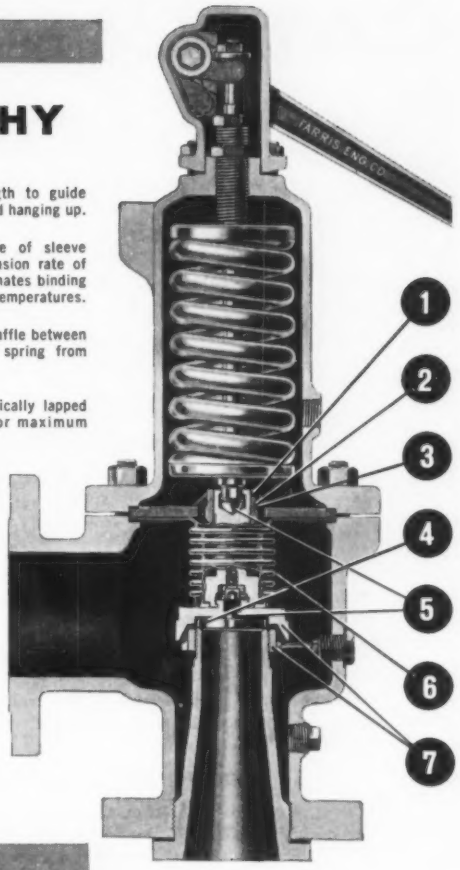
3 Sleeve guide provides solid baffle between body and bonnet, shielding spring from lading fluid.

4 Hardened stainless steel optically lapped flat disc – self aligning for maximum tightness.

5 Double universal ball joint from stem to disc for self alignment – eliminates effects of spring, temperature and piping distortion.

6 Stainless steel "BALANSEAL" bellows nullifies effect of back pressure and isolates internal working parts from lading fluid.

7 Cone-shaped disc holder directs flow away from guiding surfaces and forms fixed secondary orifice with single blowdown ring control for built-in capacity.



Farris full nozzle Safety-Relief Valves

Simplicity in design, safety in operation . . . what more can you ask of a Safety-Relief Valve! The patented design features shown in this Farris valve have been *standard* for more than a decade. It's the ideal concept of a trouble-free, safe, safety valve, free from inventory and design change problems since 1945. It's the *preferred design* in full nozzle safety-relief valves for the process industry.

Detailed information for the selection and sizing of all Farris process safety-relief valves is in Catalog FE-118. Sent to you on request.

PROGRESS THROUGH Farris HONEST PURPOSE

ENGINEERING CORP.
536 Commercial Avenue, Palisades Park, N.J.
Texas Plant: 5405 Clinton Drive, Houston 20

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HARSHAW CATALYSTS

WILL DO A *GIANT'S* WORK FOR YOU

Harshaw Catalysts do a giant's work and Harshaw produces catalysts in giant quantities—carloads every week. A letter or phone call will put our 20 years' experience and acres of production and research facilities to work for you.

CATALYTIC CHEMICALS SUPPLIED BY HARSHAW

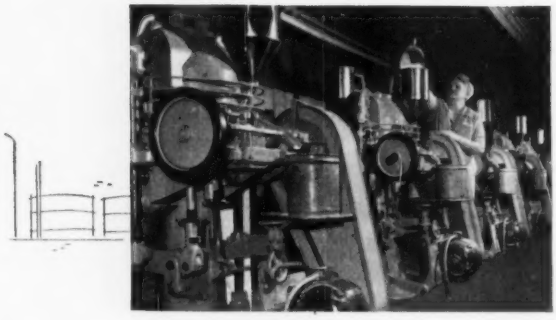
Aluminum Nitrate — Cobalt Nitrate
Copper Nitrate — Manganese Nitrate Solution
Metallic Soaps (Cobalt, Manganese)
Nickel Carbonate — Nickel Formate — Nickel Nitrate
Nickel Sulfate — Sodium Methoxide — Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

PREFORMED CATALYSTS

to fit special process requirements

Hydroforming	Dehydrogenation	Alkylation
Cyclization	Dehydration	Hydrogenation
Oxidation	Desulphurization	Hydro treating
	Chlorination	



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Building . . .

mitters, colorimeters and other instruments developed to analyze continuously or at short-time intervals.

Although there are no definite plans at the present time, the company says equipment may be developed which will use radiation signals to measure other processing factors such as liquid levels in processing units.

Pacific Petroleums, Ltd. has begun a refinery expansion program in northern British Columbia which includes enlargement of the McMahon natural gas plant and refinery at Taylor, and additional work at the Dawson Creek refinery. The expansion will result in increased utilization of natural gas liquids from the McMahon plant, which produces dry pipeline gas from wet natural gas. By-products include natural gasoline, propane, butane, motor fuels, diesel fuels and other liquids and elemental sulfur. Also expanded will be Dawson Creek asphalt facilities.

British Petroleum Corp. has completed a 35,000-bpd distillation unit at its Grangemouth, Scotland, refinery. This ends the first stage in a $17-million project to raise the refinery's annual throughput capacity from 49,000 to 84,000 bpd. Other units being built include a deethaniser to improve propane gas, a copper chloride gasoline-sweetening unit, and gas oil and kerosine treatment plants. In the power house a boiler for raising 150,000 pounds of steam an hour has been completed and a 2,250-kilowatt electrical generator, driven by an experimental gas turbine, is being installed.

Esso Standard Oil Co.'s Baton Rouge refinery shaved at least 18 weeks off "normal" construction schedules in bringing its new high-purity ethylene recovery unit, seriously damaged by fire last October, back to capacity production. The refinery said the work would usually take nine months to a year. Several fire-protection and fire-control projects were included in the program. Also, new steam boilers were installed to recover waste heat from the turbines.

Arkansas Fuel Oil Corp. plans to begin immediate construction of a $1.25-million gas processing plant near Kingsville, Texas. Average daily capacity will be 34-MMcf of gas per day, which will produce 29,000 gallons of natural gas liquids. The plant is designed to recover 76 percent of the propane and most of the heavier hydrocarbons in the gas.

Maximum design gas capacity is 50 MMcf per day, and design allows for future expansion. The absorber will operate at zero degrees and 920-psi pressure. Both the inlet gas and absorption oil will be chilled by mechanical refrigeration. Inlet gas will be dehydrated by the injection of glycol. Light weight absorption oil will be used to effect high

PERFORMANCE FOR SALE!

with Hartzite Plastic Adjustable Pitch Cooling Tower and Heat Exchanger Fans

Good performance costs nothing extra ... yet saves so much.

This statement sums up the performance and economy of Hartzell Adjustable Pitch fans made from Hartzite plastic.

Since its introduction in 1941, Hartzite plastic has practically eliminated fan blade replacement problems while providing high efficiency operation.

Hartzite blades have been job-proven on thousands of installations to effectively resist corrosion, abrasion and vibration. Increased strength and efficiency are achieved by use of a tapered blade and a heavily reinforced leading edge.

Welded steel hubs are dynamically balanced and each blade is balanced to a master blade. Gussets provide extra strength and increased safety.

Hartzite fans are available in 10′ to 22′ sizes. Hubs are designed for 2, 3, 4 or 6 blade assemblies.

Again . . . good performance costs nothing extra . . . yet saves so much. Write for all the facts on how Hartzell fans can cut maintenance costs and provide economical, high efficiency operation.

Other famous Hartzell products include controllable and full feathering propellers for light aircraft, crop drying equipment, and farm ventilating fans.

HARTZELL

Engineering Offices in Principal Cities

HARTZELL PROPELLER FAN CO.

Div. of Castle Hills Corp. Piqua, Ohio

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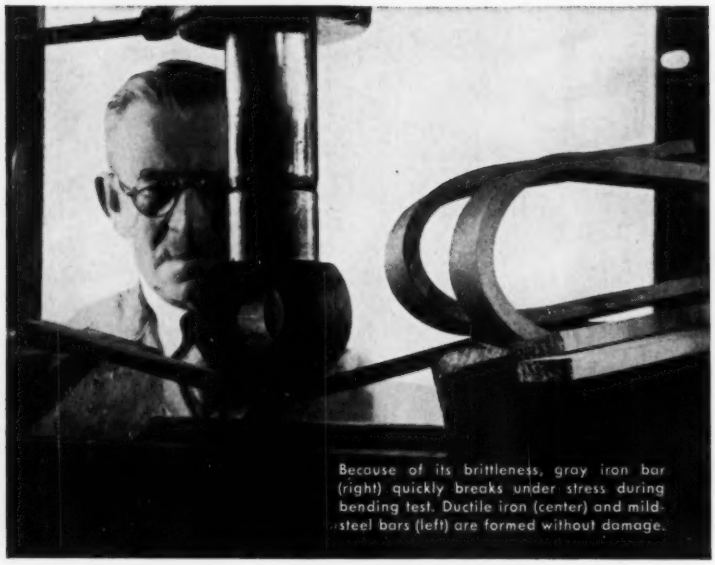


Because of its brittleness, gray iron bar (right) quickly breaks under stress during bending test. Ductile iron (center) and mild-steel bars (left) are formed without damage.

NEW THROUGH FLUIDICS

Glassed "ductile iron" fittings* with strength comparable to Glasteel's

Now you can specify glassed-metal fittings and valves with the same confidence buyers have in Glasteel equipment.

New to the Pfaudler line is a series of glassed *ductile iron* fittings exhibiting physical and chemical properties similar to Glasteel 59's.

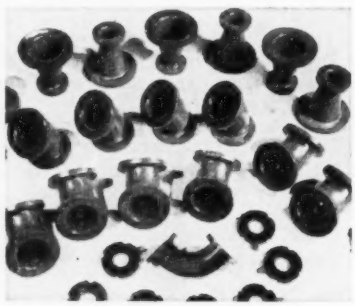
High Strength: 60,000 tensile; 45,000 yield and 15% elongation per ASTM-A-395-56T and ASTM-A-339-55. Other types available on request. Ductile iron, after glassing, is 2½ to 3 times stronger than low-strength gray iron.

Improved Thermal Shock: Far superior to glassed gray iron—now comparable to the thermal shock resistance of Glasteel 59.

Excellent corrosion resistance: Resistant to all acids (except hydrofluoric) even at elevated temperatures and pressures, and to most alkaline solutions at moderate temperatures.

Acceptance: Because of its superior strength, ductile iron #60-45-15 is widely used in the petroleum industry.

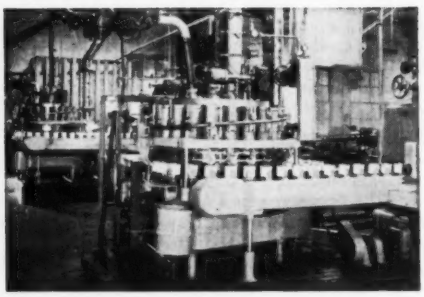
Availability: July 1st delivery on these types and sizes: 45° and 90° elbows, tees and crosses in 1½, 2, 3, 4 and 6 inch.



If you've wanted the corrosion resistance and strength of glassed metal, but have ruled out gray iron fittings, you'll want to inquire about glassed "ductile iron" fittings from Pfaudler.

To get the information, just circle the "A" on the coupon.

*Pat. Pending



FLUIDICS AT WORK

How Texaco packages a complete lube line with just three fillers

Texaco's Port Arthur plant is holding filling costs to a minimum by using just three Pfaudler fillers to package a complete line of motor oils, hydromatic fluids, and anti-freeze in quarts and gallons.

Part of the story is speed . . . fast filling without spilling. Two of the fillers handle quarts filling 410 to 425 cans a minute, each holding an extra 65 quarts per minute capacity in reserve. The third machine handles gallons at 60 to 80 per minute.

These machines permit the filling of cans with little or no spillage. As a result, cans and shipping cases do not become oil stained. Accuracy of fill is maintained. Maintenance of equipment is reduced to the minimum.

Another part of the story is cleaning. One man can clean one of these machines completely in a half hour. He empties the bowl through a drain port, flushes with kerosene, puts the machine through a few revolutions, and he's done.

The last part of the story is low parts replacement. There are only three primary wearing parts on Pfaudler fillers: piston and valve rollers and valve trip cams.

All are inexpensive and easy to replace. There are no connecting rods or wrist pins to cause trouble and expense.

If you'd like to find out how these machines can fit into your filling operation, circle "B" on the coupon.

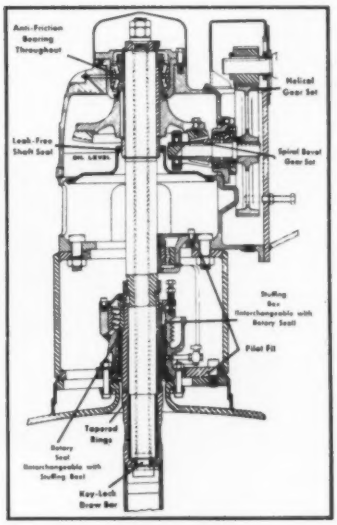
DICS

is a Pfaudler Permutit program providing the know-how the equipment and the experience for solving problems involving fluids

FLUIDICS covers such varied phases of fluid handling and control as:

corrosioneering
water treatment
waste treatment
reactions
polymerization
ion exchange
fluid analysis, metering and control
agitation
evaporation
distillation
drying
blending
metering
valving
flow rate control
piping
storing
centrifuging
filling
heat transfer, etc.

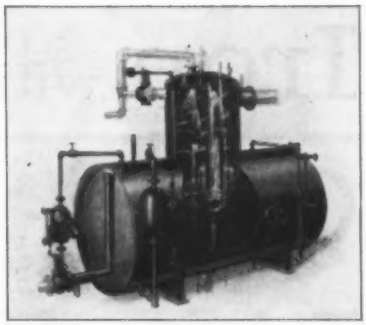
Whenever you have a fluid-handling problem, look to this Pfaudler Permutit FLUIDICS program for the best solution.



FLUIDICS AT WORK

Cut maintenance up to 50% with new BH drive

Among the many new features on this drive is perfect alignment in minutes; pedestal mount is keyed to drive unit with pilot fit, locks to drive in just the right position for perfect alignment. Only two bearing areas on shaft for greater bearing spread. You get less run-out, less agitator shaft whip, longer drive life. Preassembled Pfaudler-pac stuffing box or mechanical seal slips into place without removing drive from mount. Circle "C" on coupon for bulletin.



FLUIDICS AT WORK

New deaerator scrubs water to 0.005 ml/l of oxygen

If you're looking for a way to free water almost completely of gases, you'll look far before you find a more efficient unit than this Permutit Type B deaerator.

You can push as much as 150,000 lbs/hr through one of these and reduce the oxygen content to as little as 0.005 ml/l.

Our Type A deaerators handle up to 3,000,000 lbs/hr, if you're interested in really large capacity.

Both types are available in either horizontal or vertical designs.

For details, circle "D" on the coupon.

PFAUDLER PERMUTIT INC. ▪ **Pfaudler Div., Dept. PR-49, Rochester 3, N. Y.**

Circle items wanted: A B C D

Name.....

Title.....

Company.....

Address.....

City.....Zone.....State.....

75 YEARS CREATING FOR TOMORROW Pfaudler

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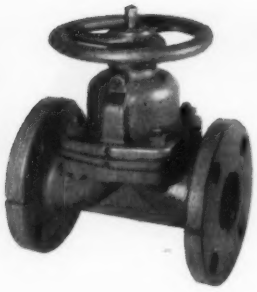
Now...you can have Grinnell-Saunders Diaphragm Valves of



Ductile Iron with Glass-Lined Bodies

After long research, Grinnell has available top quality, corrosion-resistant glass lined bodies for its line of rugged ductile iron valves.

EXTRA TOUGHNESS The greater toughness of ductile iron resists impact, torsion, line strains and thermal shock. Grinnell-Saunders valves of ductile iron handle severe service requirements where both internal and external impact shocks may be expected, and where piping stresses from rapid heating and cooling occur.

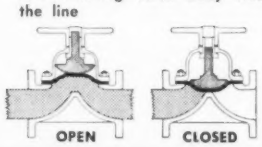
ECONOMY Approved and used by leading industries, ductile iron offers many of the benefits of cast steel at a lower price.

Of particular importance to users of Grinnell-Saunders valves is that ductile iron bodies can now be *glass-lined*—a procedure not practical with cast steel bodies.

WIDE SELECTION Body linings: glass, rubber, neoprene. Diaphragms: soft natural rubber, natural rubber, white synthetic rubber, neoprene, reinforced neoprene, butyl, Hycar, Teflon, Kel-F, PVC (polyvinyl chloride), polyethylene. Bonnet materials: ductile iron, grey iron. Bonnet styles: handwheel (non-indicating stem or indicating stem), chain wheel, lever for quick operation, and sliding stem for a wide selection of power operated topworks.

Important features of the Grinnell-Saunders Diaphragm Valve

- Diaphragm completely isolates operating mechanism from the fluid in the line
- Diaphragm lifts high for full, streamline flow in either direction
- Diaphragm effects positive, leak-tight closure
- Diaphragm easily replaced without removing valve body from the line



GRINNELL-SAUNDERS DIAPHRAGM VALVES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

Building . . .

propane recovery, with a minimum of absorption oil being circulated. Electric power will be purchased for operation of all pumps and fans. Natural-gas fuel requirements will be small, being limited to gas-engine-driven compressors and gas-fired heaters.

AFO will operate the plant and will have about 80 percent interest. Other owners are Heep Oil Corp., Sun Oil Co., J. Ray McDermott and Co., Mokeen Oil Co., Renwar Oil Corp. and Champlin Oil & Refining Co. The plant, to be on a 75-acre site 15 miles southeast of Kingsville, will be built by Delta Engineering Corp. Plans call for operation by October.

The Soviet Union is preparing to build a "large refinery" in East Germany, as provided in a recently signed German-Soviet trade pact. The plant is to be built near the terminus of the Russian-East German pipe line through which the Soviets expect to pump 100,000 bpd by 1965.

Shell Refining Co. (Philippines) Inc., a newly formed British-Philippine company in which the latter's interest is 25 percent, plans to build a 25,000-bpd refinery on Luzon, P. I. Construction is expected to take two to three years.

Barnwell Production Co., Shreveport, plans immediate construction of a refinery in the McComb, Miss., area, according to L. B. Manley, company official.

Syria is planning to construct an oil refinery at Karatchuk to supply Jazirah-region farmers with "inexpensive" oil products.

Shell Oil Co. is planning construction of a $1-million gas plant near McComb, Miss. Details of the project have not been disclosed.

United Arab Republic is planning a small refinery near Kameshli, on the Turkish border, to process crude oil from the Karachok field.

American Petrolfina Co. of Texas has completed a 1,500-bpd alkylation unit at its Mt. Pleasant, Texas, refinery. The unit is part of the company's $3-million modernization program begun early last year.

Bay Petroleum Co. is building a natural gas processing plant on Copano Bay near Rockport, Texas. Construction by O. L. Olsen Co., Houston, is underway, and the plant is expected to begin operations this fall. Designed to process 50-MMcf of natural gas per day, the plant will extract a mixed stream of propane, normal butane, iso-butane and

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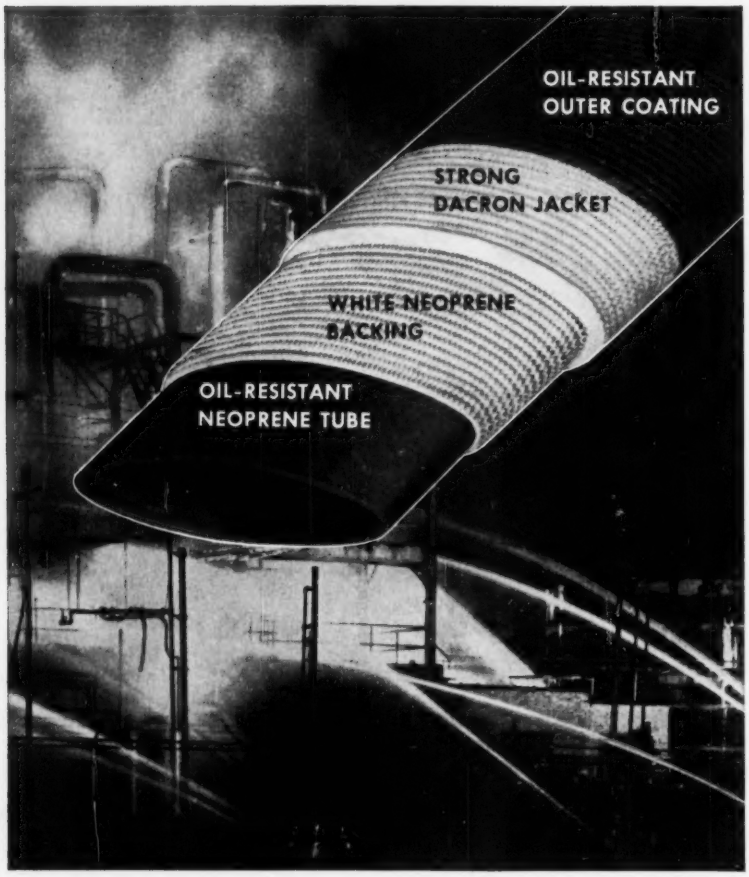

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Building . . .

natural gasoline, with a daily production of 32,800 to 42,000 gallons.

The entire output will go to Bay's liquid hydrocarbons fractionating plant near La Porte, Texas. A 12-mile, 4-inch pipeline will connect with a products pipeline which Bay operates along the Texas Gulf Coast. The plant-site is a 30-acre tract eight miles northeast of Rockport.

Oil Sands, Ltd. and L. R. Champion Co. plan to build a 20,000-bpd tar sands processing plant within a year in Canada's Athabasca tar sands area. The oil is expected to be about 30 gravity and would be extracted by hot-water processes.

Irish Refining Co., Ltd. has almost completed its 40,000 bpd refinery in Ireland. The project was begun in September, 1957, and will go on stream in May. Products will include premium and regular gasoline, kerosine-type jet fuel, propane, butane, and lubricating oils. Construction is being handled by the Esso Petroleum group, which will manage the refinery until it goes into operation—then act in an advisory capacity.

Ente Nazionale Idrocarburi is considering construction of a refinery in Morocco. The Moroccan government has reportedly signed an agreement for a 24,000-bpd plant.

E. I. duPont de Nemours & Co. is building a neoprene synthetic rubber plant near Londonderry, Northern Ireland. The plant is slated to go on stream in 1960.

Esso Petroleum Co., Ltd. has completed its $28-million petrochemical plant at Fawley, England. It has an annual capacity of 40,000 tons of ethylene and 42,000 tons of butadiene.

Continental Oil Co. plans to expand its Ponca City, Okla., grease plant at a cost of $380,000. Work will begin soon and be completed early in 1960. Automatic equipment will include mixing, flow, control temperature and other steps.

Australian Oil Refining Pty., Ltd. will expand capacity of its Kurnell refinery at Botany Bay, 20 miles South of Sidney. The expansion will include crude distillation, catalytic cracking and related equipment, and will double the present 36,000-bpd capacity. Completion is expected in two years.

Texas Butadiene and Chemical International, Ltd. is planning several petrochemical plants costing a total of $40 million in Argentina. To be located at Patagonia, near Comodoro Rivadavia,

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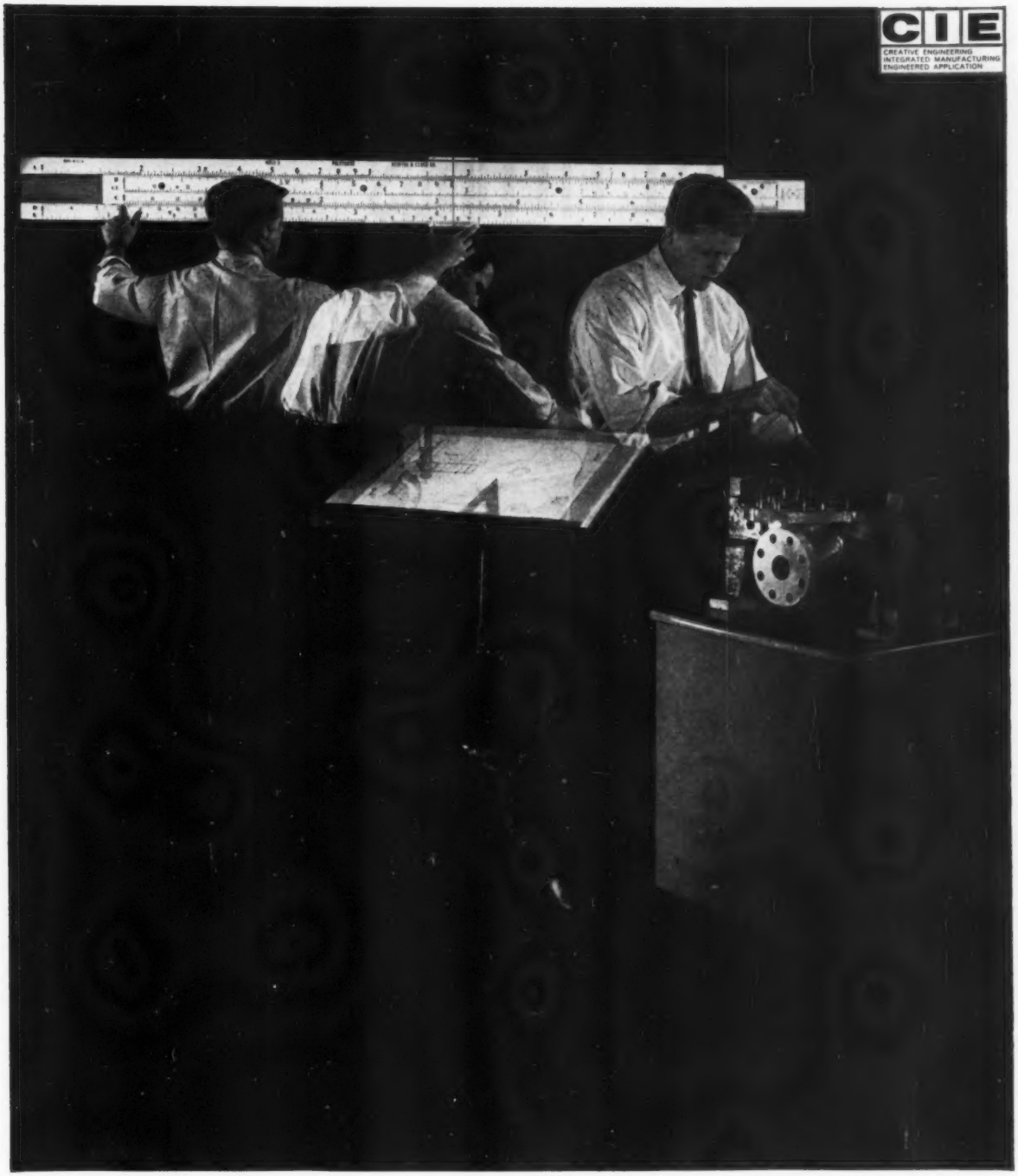

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Building . . .

they include a plant to produce 30,000 tons of butadiene, a styrene plant, carbon black plant and synthetic rubber plant with an annual capacity of 40,000 tons.

Japan is negotiating to establish a $16.5-million petrochemical plant at Chimbote port, Peru. It will produce 40,000 tons of ammonium sulfate and 20,000 tons of urea per year. The project will manufacture fertilizer to supplement the famous guano deposits of the offshore islands.

Solar Nitrogen Chemicals, Inc., has been formed by The Standard Oil Co. (Ohio), and Atlas Powder Co. It will manufacture agricultural and industrial chemicals, acquiring Sohio's present ammonia and related petrochemical facilities at Lima. The Sohio Chemical Co. will continue to operate the plant.

Standard Vacuum Oil Co.'s refinery on the Bataan peninsula in the Philippines is under construction. The 25,000-bpd plant will include catalytic cracking, reforming and polymerization units, desulfurizing units, and the Philippines' first asphalt plant. Foster Wheeler Corp. is handling construction.

Phillips Petroleum Co. will construct a 6,600-bpd alkylation unit at its Kansas City, Kans., refinery. It will be completed late in 1959. Designed and engineered by Phillips, the plant will be built by Procon, Inc.

Esso Standard Oil Co., S.A., has signed an agreement to build an $18-$20-million refinery on the island of Jamaica, West Indies. The 26,000-bpd plant is a major step in Jamaica's industrialization program. The government had been in previous negotiations for the project with several other groups as well as with Esso. The refinery's production, while finding its way into the Jamaican petroleum products market, will also be ex-

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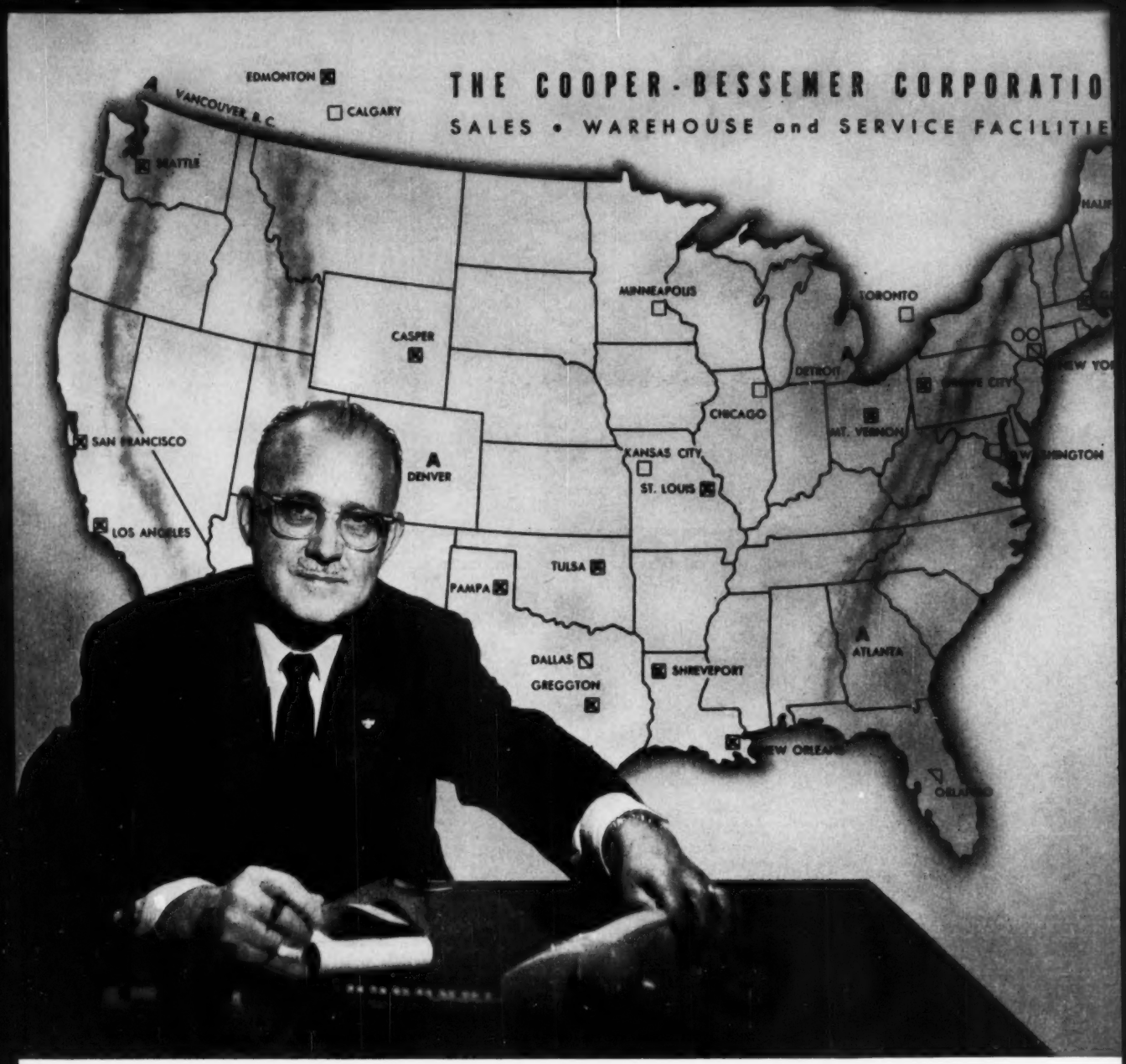

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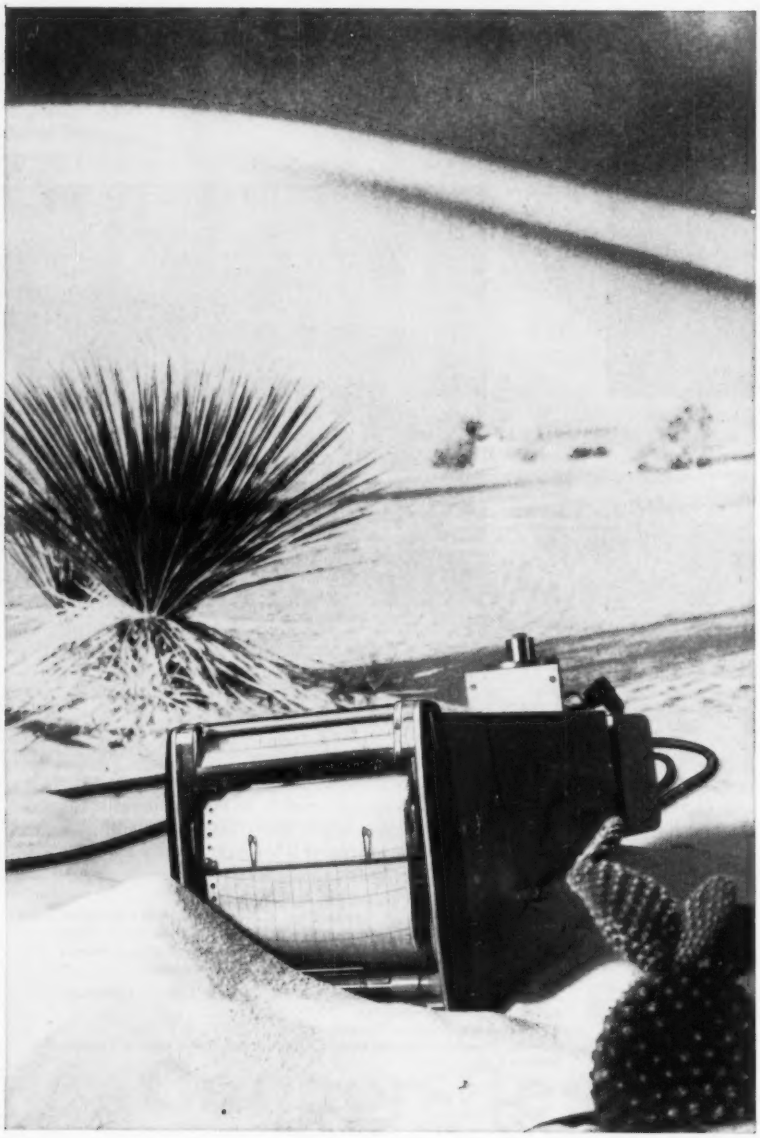

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Building . . .

ported to other Caribbean ports. Consumption of petroleum products has risen steadily in Jamaica as shown by the following table.

	Gallons 1952	Gallons 1958
Aviation Gas	4,199,793	7,450,647
Motor Gas	14,070,373	24,192,802
Kerosene	3,765,398	9,260,463
Gas Oil	9,716,070	10,145,850
Diesel Oil	6,452,628	20,417,298
Other	38,170,041	106,229,046
Totals	76,377,303	177,726,106

Gulf Oil Corp. will construct a new multi-million dollar plant for the production of oxo alcohols at its Philadelphia refinery. To quadruple the company's capacity to produce oxo products, the plant will produce iso-octyl and decyl alcohols, but will be capable of producing a broader range of alcohols and other oxo products. Engineering work has been completed and construction is scheduled to start this summer with initial operations to begin in the summer of 1960.

Caribbean Chemical and Fertilizer Co. plans to build a $15-million anhydrous ammonia and urea plant at Freeport, Grand Bahama Island, Bahamas. It will have an initial capacity of 100 tons per day of ammonia, based on a heavy-oil source for synthesis hydrogen, and 54,000 tons a year of urea. The company says the location offers tax advantages and offshore bunkering facilities in a free port.

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To eliminate pollution of air and effluent water, reduce operating costs, and to produce a sulphur free finished product, a large Gulf Coast refiner recently placed in operation the above pictured 6000 barrel per day HYDROFINING Unit designed to supplant acid treatment in processing close boiling range naphthas.

Feed stock is vaporized and mixed with hydrogen which catalytically reacts with sulphur contained in the feed stock mostly in the form of mercaptans, to form hydrogen sulphide which is further processed to recover elemental sulphur. After HYDROFINING the liquid product is washed with caustic and filtered through charcoal.

HUDSON furnished mechanical design, materials and equipment; and constructed the HYDROFINING Unit and the Fractionating Unit shown at the left of the picture.

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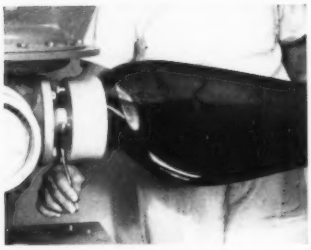
Lightweight.



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SAFE: TUF-LITE blades being lightweight (about ¼ the weight of other blades with comparable capacity) and infrangible, eliminate the hazards to personnel and equipment existent through accidental throwing or disintegration of heavy metal, wood, or laminated blades while in service.

EFFICIENT: More air is moved at less horsepower because weight and finishing operations do not impose limitations on selections of best aerodynamic design; therefore nearly ideal airfoil cross sections, commercially attainable only in TUF-LITE blades, can be used. Blades will not sag or distort, and surfaces remain permanently smooth.

LOW MAINTENANCE: TUF-LITE blades are unaffected by corrosive, abrasive or impingement effects of hot saturated air, sand, rain, or hail, and have superior deterioration resistance to practically all corrosive vapors or liquids. Blade materials contain color pigment; no painting is necessary. Light weight reduces stress and maintenance on bearings, gears, drive shafts, and supports.

QUIET: The permanently smooth surfaces, very light weight, sustained perfect balance, and advanced aerodynamic design minimize noise.

EASE IN INSTALLATION: Light weight of blades and ingenious design of hub and blade coupling allows attachment of blades by one man using only small wrench. Coupling design assures uniformity of pitch of all blades, and as blades of same size are identical and interchangeable, perfect fan balance is preassured.

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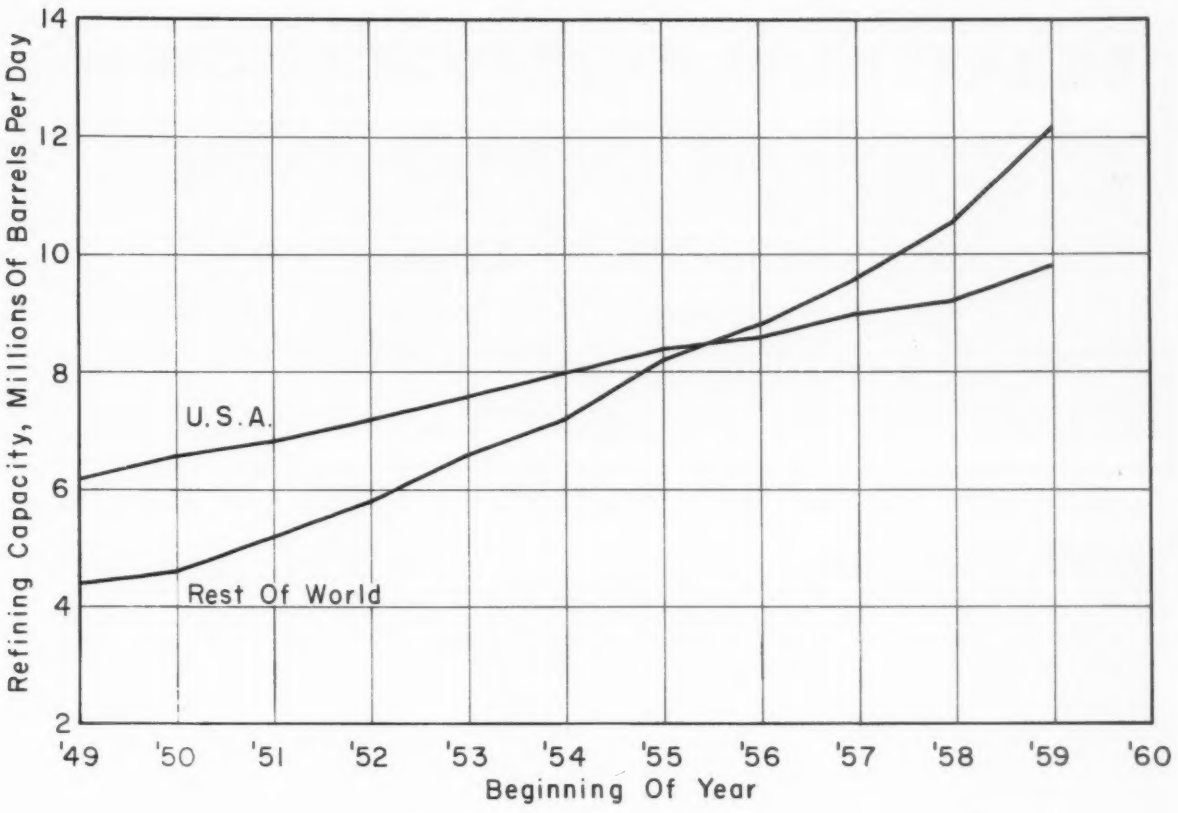


"Construction Boxscore" data reveal . . .

Big Surge Now in World Refining

Crude oil refining is moving ahead in an astonishing growth of foreign-based refineries. The recent surge in construction throughout the world is accounted for only partially by increased construction within the United States. Most of the world's increase can be attributed to installations outside the country.

The refining capacity for the United States and for the rest of the world are shown in Figure 1. These data include estimates concerning countries for which information is limited, such as the USSR and the countries she dominates.

For most of the period depicted in Figure 1, the United States has increased her refining capacity at a rate which is less than half as fast as for the rest of the world.

The United States for a long time held the distinction of having more refining capacity than the rest of the world combined. This situation, however, no longer existed after 1955. Thereafter, the increased construction abroad made the U.S. continue to lose ground in the overall picture. Nevertheless, the United States is destined to outrank any other single country for a long time by having the greatest concentration of refining anywhere.

A look through PETROLEUM REFINER's past issues of "Construction Boxscore" will reveal where most of the refining capacity has gone. Aside from domestic construction, the activity in other countries involve: England, Kuwait, Japan, Italy, and France.

England gets her big push by virtue of additional crude running capacity for British Petroleum in Kent, Shell's refinery in Shell Haven, and Esso's Fawley plant. More will come, especially when Esso completes her 100,000-bpd plant at Milford Haven in early 1960.

Kuwait got its shot in the arm by the installation of two crude distillation units rated at 80,000-bpd each. These units were added to the then existing 30,000-bpd refinery of Kuwait Oil Co. in Mina Al Ahmadi.

Japan is another on a spree of refinery construction. Crude capacity was completed early last year by four companies—Showa Yokkaichi Sekiyu Co., Ltd's 40,000-bpd unit at Yokkaichi, Idemitsu Kosan Co.'s 30,000-bpd project at Tokuyama, Toa Nen-

ryo Kogyo Co.'s 25,500-bpd pipestills at Shimizu, and Mitsubishi Oil Co., Ltd's 25,000-bpd addition at Kawasaki.

As for world reserves, certainly the middle east holds the lion share. Furthermore, European, Asian, and Oriental countries are making the swing to oil-based power. These factors are strong influences for the ever-growing foreign refineries.

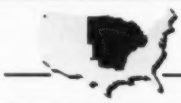
A quick glance at the "Construction Boxscore" which follows will show the many additional installations planned for the future. Crude handling facilities are reported for completion in many widely scattered countries, among them Brazil, Panama, Venezuela, Turkey, France, Germany, Ireland, Netherlands, Norway, and Syria.

Construction Boxscore

Oil, Gas and Petrochemical Processing Plants

East

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Allied Chemical & Dye	Buffalo, N.Y.	Polyethylene	.....	.....	Under Constr	.....	.....	.....	.....
American Cyanamid	Bridgeville, Pa.	Maleic Anhydride	14,000,000 lbs/yr	.....	Under Constr	Late 1959	S D	S D	S D
Atlantic Refining	Philadelphia	Vacuum Flash	40,000 bbls	.....	Under Constr	Spring 1959	.....	Hydrocarbon	Hydrocarbon
		*Dewaxer-Deoiler	10,800 bbls	.....	Under Constr	Mid 1959	.....	Badger Mfg	Badger Mfg
		Revamp Visbreaker	20,000 bbls	.....	Under Constr	Spring 1959	.....	Atlantic	Atlantic
California Oil	Perth Amboy, N.J.	Cat Reformer and Desulfurizer	10,000 bbls	$7,000,000	Under Constr	1959	.....	Ferguson	Ferguson
Chemstrand	Decatur, Ala.	Exp. Acrilan	45,000,000 lbs/yr	.....	Complete	.....	.....	Staff	Davis Constr
Coastal Chemical	Pascogula, Miss.	Ammonia	200 tons	$6,650,000	Complete	.....	.....	Chemico	Chemico
Columbia Hydrocarbon	Siloam, Ky.	Hydrocarbon Fractionation with pipe line and offsite facilities	230,000,000 gal/yr	$5,000,000	Under Constr	.....	.....	Pritchard	Pritchard
Commerce Oil Ref.	Jamestown, R.I.	Refinery:	40,000 bbls						
		Crude Distl.	25,000 bbls	$50,000,000	Engineering	.....	UOP	Fluor	Fluor
		Cat Cracking	.....						
du Pont	Belle Works, W. Va.	Urea; Ammonia Methyl Methacrylate, Nylon Intermediates	.....	.....	Planned	1959	Texaco	.....	.....
	New Jersey	Hydrogen	.....	.....	Engineering	.....	.....	Chemico	Chemico
Esso Standard	Bayway, N.J.	*Exp. Cat Cracker Light Ends	.....	.....	Engineering	Early 1960	.....	.....	.....
Goodyear	Point Pleasant, W. Va.	Polyesther Resin	.....	$10,000,000	Complete	.....	.....	Catalytic	Catalytic
Gulf Oil	Near Charleston, S.C.	Refinery	.....	.....	Planning	.....	.....	.....	.....
Hercules	Hopewell, Va.	Caprolactam Monomer Exp.	60,000,000 lbs/yr	.....	Under Constr	.....	.....	.....	.....
Hess	Perth Amboy, N.J.	Unifiner-Platformer	5,000 bbls	.....	.....	.....	.....	.....	.....
		No. 2 Fuel Oil Unifiner	5,000 bbls	$1,500,000	Under Constr	.....	UOP	Treco	Treco
Mississippi Chem.	Pascagoula, Miss	*Urea	100 tons	.....	Under Constr	June 1959	Inventor Uhde	Vulcan	Vulcan
Reichhold Chemicals	Hampton South Carolina	Formaldehyde	30,000,000 lbs/yr	.....	Engineering	.....	.....	.....	.....
	Tuscaloosa	Formaldehyde	35,000,000 lbs/yr	.....	Planning	.....	Staff	Staff	Staff
Shell Oil	Little Creek, Miss.	*Nat. Gas Liquids	5-Mcf	.....	Planning	.....	.....	.....	.....
Sinclair	Marcus Hook	*Hydrodesulfurizer	20,000 bbls	$2,400,000	Engineering	Late 1959	.....	Catalytic	Catalytic
Socony Mobil	Paulsboro, N.J.	Delayed Coker	19,000 bbls	.....	Complete	.....	.....	Lummus	Lummus
		Sulfur Recovery	80 tons	$700,000	Complete	.....	.....	Badger Mfg	Badger Mfg
	Buffalo, N.Y.	2 Stage Crude Distl.	28,500 bbls	.....	Complete	.....	.....	Lummus	Lummus
		Alkylation	2,440 bbls	.....	Complete	.....	.....	Kellogg	Kellogg
SunOlin Chem.	North Claymont, Del.	*Urea	200 tons	$10,000,000	Engineering	Early 1960	Montecatini	Kellogg/Staff	Kellogg
Union Carbide Chemicals	Institute, W. V.	Exp. Acrylonitrile	.....	.....	.....	.....	.....	.....	.....
		*Epoxies	10,000,000 lbs/yr	.....	Under Constr	1959	.....	.....	.....
	Winfield, W.V.	Petrochemical	.....	.....	Complete	.....	.....	.....	.....
United Refining	Warren, Pa.	Crude Distl.	15,000 bbls						
		Cat Reformer Revamp	4,000 bbls	.....	.....	.....	.....	Staff	Staff
		Depentanizer	5,000 bbls						
		Cat Cracker Revamp	5,000 bbls						



Mid-Continent

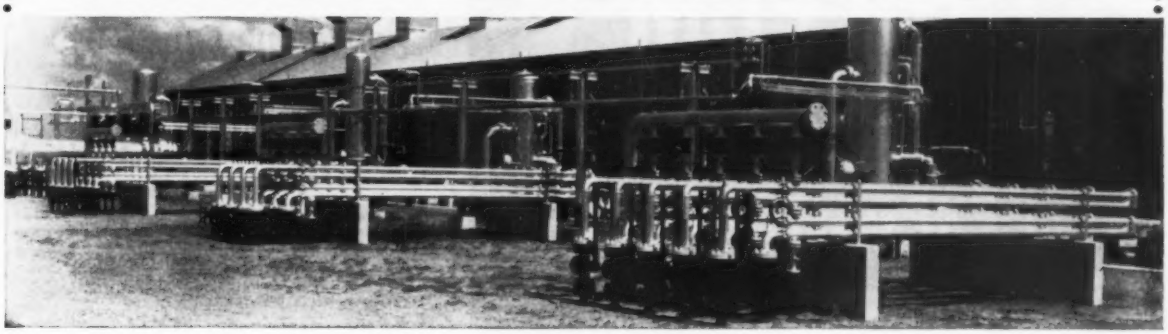
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Ashland O & R	Catlettsburg, Ky.	*Aliphatic Solvents	.....	.....	Under Constr	July 1959	.....	Procon	Procon
Aurora Gasoline	Detroit	Vacuum Distl.	18,000 bbls	.....	Under Constr	Early 1959	.....	Treco	Treco
		*Alkylation	2,000 bbls	.....	Engineering	Late 1959	.....	Treco	Treco
Bay Refining	Bay City, Mich.	Crude Distl.	12,000 bbls	$900,000	Under Constr	Mid 1959	.....	Sweco	Sweco
		Alkylation	850 bbls	$850,000	Under Constr	Mid 1959	UOP	Sweco	Sweco
Callery Chemical	Muskogee, Okla.	Hydrogen	800,000 scf	.....	.....	.....	.....	.....	.....
		Carbon Dioxide	7,790 lbs hr	.....	.....	.....	.....	.....	.....
Carter Oil	Billings, Mont.	Alkylation	2,300 bbls	.....	Under Constr	May 1959	UOP	Treco	Treco
		Convert Bauxide Desulfurizing to Hydrofiner	11,000 bbls	.....	Under Constr	May 1959	Esso	Treco	Treco
Cities Service	East Chicago, Ind.	Cat. Reformer	7,500 bbls	$4,000,000	Complete	.....	UOP	Staff/Procon	Procon
Cooperative Farm Chemicals	Lawrence, Kan.	Ammonia Urea	100 tons/30 tons	$5,400,000	Engineering	August 1959	.....	Chemico	Chemico
Derby Refining	Wichita, Kan.	Alkylation	1,700 bbls	$1,500,000	Under Constr	May 1959	.....	Procon	Procon
		Waste Disposal, Cooling Tower, LPG Storage	.....	$405,000	Under Constr	June 1959	.....	Litwin	Kaighin Hughes/Litwin/Staff
		*TCC/Gas Concentration	.....	$800,000	Complete	.....	Socony	Litwin	Litwin

• First appearance in tabulation.

Construction BOXSCORE Continued on Page 207

NO HEAT EXCHANGER GRAVEYARDS

with Brown Fintube Modular Units



THE TOP PHOTOGRAPH is an actual picture of a salvage yard at a large processing plant. It represents a loss of thousands of dollars in heat exchangers that must be scrapped because they were individually designed for only one duty.

SUCH WASTE could never happen to the Brown equipped plant shown above. The same basic Brown Heat Exchanger section is used for all services. *The proper combination of these units will meet any required duty*. Brown Heat Exchangers are changed by the addition of or subtraction of sections on short notice. In fact, they can be moved to another plant location, thousands of miles distant, if necessary. As a result they are never scrapped.

SAVE your company thousands of dollars annually by changing to a standardized Brown system. The benefits of no obsolescence, reduced stores, parts, maintenance, plus higher efficiency are the reasons for the widespread use of these units in only a few years.

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BROWN FINTUBE
HEAT TRANSFER PRODUCTS

BROWN FINTUBE CO.

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FREE SPECIFICATIONS MANUAL!

Please send a copy of your Heat Exchanger Specifications Manual M-100 which will help us save costs by standardizing on one basic heat exchanger unit.

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PR 459

THERE'S *MORE* TO HEAT EXCHANGERS THAN INITIAL PRICE!

SEE OUR EXHIBIT, BOOTH 141, WORLD PETROLEUM CONGRESS EXPOSITION, NEW YORK, JUNE 1-5

For more data on advertised products, use Readers' Service Cards, last page.

KELLOGG WELCOMES YOU

... and cordially invites you to see two of its advanced engineering and design techniques in actual operation— both at the New York Coliseum, June 1-5, and at M. W. Kellogg's New York headquarters, May 25—June 5...

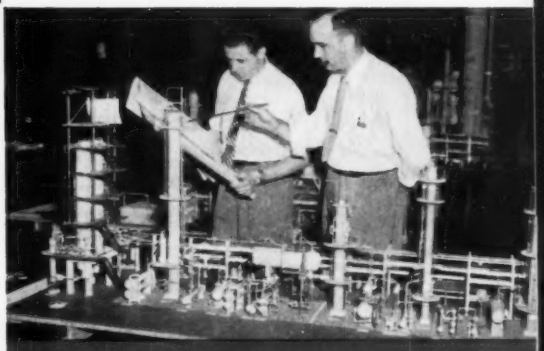
WORLD PETROLEUM CONGRESS and EXPOSITION

WHEN IN NEW YORK for the Congress, refiners interested in advanced engineering and design techniques should plan to see the practical demonstrations of Kellogg's computer-programming and model-building developments. Both can be seen at Kellogg's exhibit at the Coliseum, Booth 510 (second floor, center aisle) or at Kellogg's New York offices.

At the Coliseum, a Burroughs 205 Computer will run three Kellogg programs: (1) Designing a heat exchanger; (2) Computing material balances around a complete gas recovery system; and (3) Calculating streams for the cascade reactor of a Kellogg sulfuric acid alkylation unit.

Also at Booth 510, visitors may watch designers building scale models, see how model photographs are used in place of drawings, and become acquainted with the many ways in which models improve and speed designs.

Refiners wishing to pursue these two techniques further, or to learn about other Kellogg engineering practices, are invited to visit the company's New York headquarters, May 25 to June 5. Arrangements can be made at Kellogg's exhibit or by telephoning Mr. A. L. Dowling, Public Relations, at OX 7-5200.



See scale models being built

See electronic computers at work

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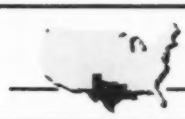
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Dow Chemical	Bay City, Mich.	Petrochemical			Under Constr	Summer 1959		Bechtel	Austin
		Polyethylene			Under Constr	Summer 1959	Zeigler	Bechtel	Bechtel
DX Sunray	Duncan, Okla.	*Cat Cracker Revamp		$600,000					Treco
Goodyear Tire & Rubber	Point Pleasant, W. Va.	Polyester Resin		$10,000,000	Planning				
Grace Chemical Div. W. R. Grace & Co.	Memphis, Tenn.	Urea Exp.	300 tons		Under Constr	1959		Foster Wheeler	Process Contracting
Gulf Oil	Toledo	Alkylation	2,000 bbls		Under Constr	1959		Kellogg	Kellogg
Leonard Refineries	Alma, Mich.	Cat Cracker	7,500 bbls	$3,000,000	Complete		UOP	Parsons	Parsons
		Alkylation	1,000 bbls	$1,100,000	Complete		UOP	Parsons	Parsons
Lion Oil	El Dorado, Ark.	Unifiner—Platformer	5,000 bbls	$1,600,000	Engineering		UOP	UOP/Procon	Procon
		*Tetramer	5,500 bbls		Under Constr	Oct. 1959	UOP	Procon	Procon
Monsanto Chemical	Monsanto, Ill.	Phenol Exp.							
	El Dorado, Ark.	Urea Distl.			Under Constr			Chemico	Chemico
		*Solvent Deasphalting	5,260 bbls		Under Constr	Spring 1959			Badger Mfg
Naph-Sol Refining	Muskegon, Mich.	Exp. Crude Distl.	10,000 bbls		Complete			Litwin	Litwin
Northwestern Ref. Co.	St. Paul Park, Minn.	Cat Reformer			Planning	1959			
Ohio Oil	Robinson, Ill.	Heater Addition to Delayed Coker	1,400 bbls		Complete			Lummus	Catalytic
Phillips Pet.	Kansas City, Kan.	*Alkylation	6,000 bbls		Under Constr	1960	Phillips	Phillips	Procon
Reichhold Chemicals	Detroit	Formaldehyde	35,000,000 lbs/yr		Planning		Staff	Staff	Staff
	Kansas City, Kan.	Formaldehyde	35,000,000 lbs/yr	$500,000					
R & J Oil & Ref.	Princeton, Ind.	Unifiner	1,700 bbls.		Planning				
		Crude Distl.	5,000 bbls		Under Constr	June 1959			
		Platformer	1,700 bbls		Planning				
Shell Oil	Wood River, Ill.	Exp. Lube Oil	4,000 bbls		Engineering	Mid 1959		Lummus	Lummus
		Offsite Facilities		$10,000,000	Engineering	Mid 1960		Parsons	Parsons
	S. Roxana, Ill.	*Hydrotreater	25,000 bbls		Under Constr	June 1959			Procon
	Healdton, Okla.	Exp. Plant		$315,000	Under Constr			Staff	Hudson
Sinclair Refining	East Chicago	Alkylation/LPG			Engineering			Braun	Braun
		*Asphalt Blending			Under Constr	May 1959		Sinclair	Catalytic
Skelly Oil	El Dorado, Kan.	HF Alkylation	3,000 to 4,000 bbls		Engineering		Phillips	Staff	Staff
		*Gasoline Treater	5,000 bbls		Engineering	Late 1959		Litwin	Staff
		*Vacuum Distl.	12,000 bbls		Under Constr	Mid 1959		Litwin	Staff
Socony Mobil	East St. Louis	Pretreater	16,000 bbls		Planning			Fluor	Fluor
Standard-Indiana	Whiting, Ind.	Crude Distl.	140,000 bbls		Under Constr	1959		McKee	McKee
		Vacuum Distl. Tower	36,000 bbls		Under Constr	3rd Qtr. 1959		Braun	
		Exp. Cat Cracker	10,000 bbls		Engineering	1960		Kellogg	
	Wood River, Ill.	Crude Unit	67,500 bbls		Under Constr	1959		McKee	McKee
		Cat Cracker	30,000 bbls		Under Constr	Early 1959		McKee	McKee
		Vacuum Distl. Tower	36,000 bbls		Engineering	1959			
Standard-Ohio	Lima, Ohio	*Exp. Lube Wax Facilities		$650,000	Under Constr				
Sun Oil	Laverne, Okla.	Gas Products Recovery			Under Constr	July 1959		Pritchard	Pritchard
Sunray Mid-Continent	McClain County, Okla.	*Natural Gasoline	5 Mmcf	$1,000,000	Planning	Late 1959			
Texaco	Lawrenceville, Ill.	Cat Reformer	12,000 bbls		Under Constr	4th Qtr. 1959		Bechtel	Betchel
		Hydrotreater	12,000 bbls		Under Constr	4th Qtr. 1959		Bechtel	Bechtel
	Tulsa, Okla.	Alkylation	2,050 bbls		Under Constr	4th Qtr. 1959			
Union Carbide	Marietta, Ohio	Liquid epoxy resin	15,000,000 lbs/yr		Under Constr	1959			
	Whiting, Ind.	Low-density Polyethylene	72,000,000 lbs/yr		Under Constr	Mid 1959			
Warren Petroleum & Sunray	Forgan, Okla.	Gasoline	100 Mmscf	$3,000,000	Engineering				Dresser
Witco Chemical	Chicago	Phthalic Anhydride	20,000,000 lbs/yr		Under Constr	Early 1959	S D	S D	S D



Southwest

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
American Cyanamid	Fortier, La.	Acrylonitrile	100,000,000 lbs/yr	$25,000,000	Complete			Chemico	Chemico
American Oil	Texas City	Heating Oil System			Complete			Tellepsen	Tellepsen
		Two Stage Distl.			Complete			Staff	Tellepsen
American Petrofina of Texas	Mt. Pleasant, Texas	Platformer	3,000 bbls	$800,000	Under Constr		UOP	Pritchard	Pritchard
Atlas Processing	Shreveport, La.	Alkylation	1,400 bbls	$1,000,000	Under Constr		UOP	Pritchard	Pritchard
Bay Petroleum	New Orleans	Deisopentanizer	4,700 bbls	$3,000,100					
		*Alkylation	2,700 bbls						
		*Exp. Cat Cracking	13,000 bbls		Under Constr	Early 1960			
		*Exp. Crude Distl.	33,000 bbls						
Calcasieu Chemical	Lake Charles	Ethylene Oxide; Ethylene Glycol	8,000,000 gal/yr		Complete		Shell		Lummus
Carbide & Carbon	Seadrift, Texas	Ethylene Oxide Exp.	To 200,000,000 lbs/yr		Planning				
		Exp. Ethylene Glycol	To 65,000,000 lbs/yr		Planning				
Champlin O & R	Bishop, Texas	*Gas Processing Exp.		$3,000,000	Under Constr	July 1959		Fluor/Staff	Fluor/Staff
Chemoil Corp.	Baton Rouge	Refinery	40,000 bbls	$35,000,000					
Cities Service	Lake Charles, La.	Exp. Reforming Cap.			Planning				
Continental Carbon	Ponca City, Okla.	Exp. Carbon Black	75,000,000 lbs/yr		Under Constr	Fall 1959			
Copolymer Rubber & Chemical	Baton Rouge	Butadiene Exp.	35,000 short tons yr		Under Constr				
Dow Chemical	Plaquemine, La.	Ethylene and Propylene Glycols and Oxides, Chlorinated Solvents			Complete			Bechtel/Sterns-Roger	Sterns-Roger/ Tellepsen
	Freeport, Texas	Chlorine, Ethylene Oxide			Complete				
		Acrylonitrile			Under Constr				
		Polyethylene			Under Constr				
		Polyglycol			Complete				
du Pont	Orange	Polyethylene			Under Constr				
	Beaumont	Caprolactam	50,000,000 lbs/yr		Planning	Late 1960		Staff	Staff
	Near New Orleans	Petrochemical			Considering				
El Paso Natural Gas	Odessa, Texas	Alkyaltion Blending			Complete				
		Dehydration			Complete			Braun	Braun
	Crane, Texas	Exp. Compression and Treating		$2,000,000	Under Constr			Olsen	Olsen
Firestone	Orange, Texas	*Polyisoprene Polybutadiene	30,000 tons/yr		Engineering				
Goodrich-Gulf Chemicals	Port Neches, Texas	Exp. Synthetic Rubber		$1,000,000	Under Constr	1959		Catalytic	Catalytic
Gulf Oil	Port Arthur	Greasemaking; Packaging			Under Constr			Sumner Sollitt	Sumner Sollitt
		Gasoline Processing	10,000 bbls	$4,000,000	Under Constr		UOP	Procon	Procon
		Benzene	82,000 gals	$6,800,000	Under Constr	May 1959	UOP	Procon	Procon

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 208

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Humble	Baytown, Texas	Phenol Lube	31,500 bbls		Under Constr	Aug. 1959		Kellogg/B & R	Staff
		*Polyolefin	40,000 lbs/yr		Under Constr	Jan. 1960		Esso	Staff
	Rusk County, Texas	Remote Absorber	80 Mmcf		Engineering			Staff	
	Kleberg County, Texas	Gas Process & Cycling	800 Mmcf		Planning	1960		Staff	
Jefferson Chemical	Port Neches, Texas	Ethylene Exp.			Complete		S&W	S&W	S&W
		*Ethanolamines Revamp			Under Constr	Early 1959		Braun	Braun
		Ethanolamines			Under Constr	Early 1959		Braun	Braun
Koppers	Port Arthur	Exp. Polyethylene					Staff	Staff	Staff
La Gloria Oil & Gas	Tyler, Texas	Gas Concentration; Revamp Cat Cracker			Under Constr		UOP	UOP	B & R
Magnolia	Beaumont, Texas	Crude Distl.	100,000 bbls		Complete			Foster Wheeler	Foster Wheeler
		Cat Desulfurization	30,000 bbls		Under Constr		Socony Mobil	Staff, Foster Wheeler	Foster Wheeler
		Cat Reforming	20,000 bbls		Under Constr	Early 1960		Fluor	Fluor
	Cameron, La.	Gas Processing	120 Mmcf			Early 1959		Dresser	Dresser
McBride Refining	Port Brownsville, Texas	Refinery Exp.	12,500 bbls	$2,500,000	Planned				
Monsanto	Texas City	Exp. Acrylonitrile	100,000,000 lbs/yr		Under Constr.				
		Exp. Styrene Monomer	40,000,000 lbs/yr						
Neches Butane Products	Port Neches, Texas	Butadiene Exp.	300,000 tons/yr		Complete			Foster Wheeler	Foster Wheeler
Petro-Tex	Houston	Sulfuric Acid Alkylation	3,000 bbls		Complete		Texaco	Fluor	Fluor
		Isobutylene	2,000,000 gal/yr	$250,000	Under Constr				
Phillips Chemical	Sweeney, Texas	Ethelyene			Under Constr	Spring 1959		Staff	Staff
Phillips Petroleum	Sweeny, Texas	Hexane Isomerization	1,000 bbls		Under Constr	1959		Staff	Staff
Runnels Gas Products & Texas Gas Expl.	Eunice, La.	Gasoline Exp.	100 Mmcf	$500,000	Under Constr	July 1959		Fluor	Staff
Shell Oil	Norco, La.	Cat Gasoline Fractionator					Monsanto	Leonard	Leonard
		Platformer	16,000 bbls		Under Constr			Procon	Procon
	Weeks Island, La.	Nat. Gas Processing	120 Mmcf		Planning				
Shell Chemical	Norco, La.	Acrolein			Under Constr				
		Glycerine		$4,500,000	Under Constr	Late 1959		Staff	Parsons/Fluor
	Houston	Phenol			Under Constr	Late 1959			Kellogg
Sinclair Refining	Houston	Steam Generating & Water Treating	250,000 lbs hr	$1,500,000	Complete			Kidde Engrs	Kidde Constr
	Hulldale Field, Texas	Desulfurizer			Under Constr				
Spencer Chemical	Orange, Texas	Polyethylene Exp.	90,000,000 lbs/yr		Under Constr			Staff	Quaker
Sunray Mid-Continent	Jackson County, Texas	*Gas Recovery	30 Mmcf	$600,000	Under Constr				
		*Propane							
		*Isobutane	27,000 gals		Under Constr				
		*Butane							
		*Natural Gasoline							
Texas Eastman	Longview, Texas	Exp. Polyethylene	85,000,000 lbs/yr		Under Constr			Girdler	Hudson
Texas Natural Gasoline Corp. & Tennessee Gas Transmission	New Orleans	Natural Gasoline	150 Mmcf		Complete				Fluor
Texaco	Port Arthur	Crude Distl.	86,000 bbls		Complete			Fluor	Fluor
		Cat Cracker	60,000 bbls		Under Constr			Kellogg	Kellogg
		Exp. Alkylation	2,000 bbls		Under Constr			Staff	Staff & Others
		Cat Reformer	20,000 bbls		Under Constr	2nd Qtr. 1959		UOP	Staff & Fluor
		Udex	28,000 bbls		Under Constr	2nd Qtr. 1959		UOP	Staff & Fluor
	El Paso	Alkylation	1,600 bbls		Under Constr	4th Qtr. 1959		Texaco	
Union Carbide	Seadrift, Texas	Ester & Alcohol	100,000,000 lbs/yr		Design	1960			
United Rubber & Chemical	Baytown, Texas	Synthetic Rubber			Under Constr			Day & Zimmerman	Tellepsen
U. S. I. Chem.	Houston	Polyethylene	75,000,000 lbs/yr	$20,000,000	Under Constr	Early 1959	I.C.I.	Kellogg	Kellogg; Tellepsen
Western Nat. Gas	Brownsville, Texas	*Refinery Revamp							
	Hidalgo County, Texas	*Gasoline Extraction							
	Victoria County, Texas	*Gasoline Extraction	3,500 bbls		Under Constr				
	Aransas County, Texas	*Gasoline Extraction							

Rocky Mountain

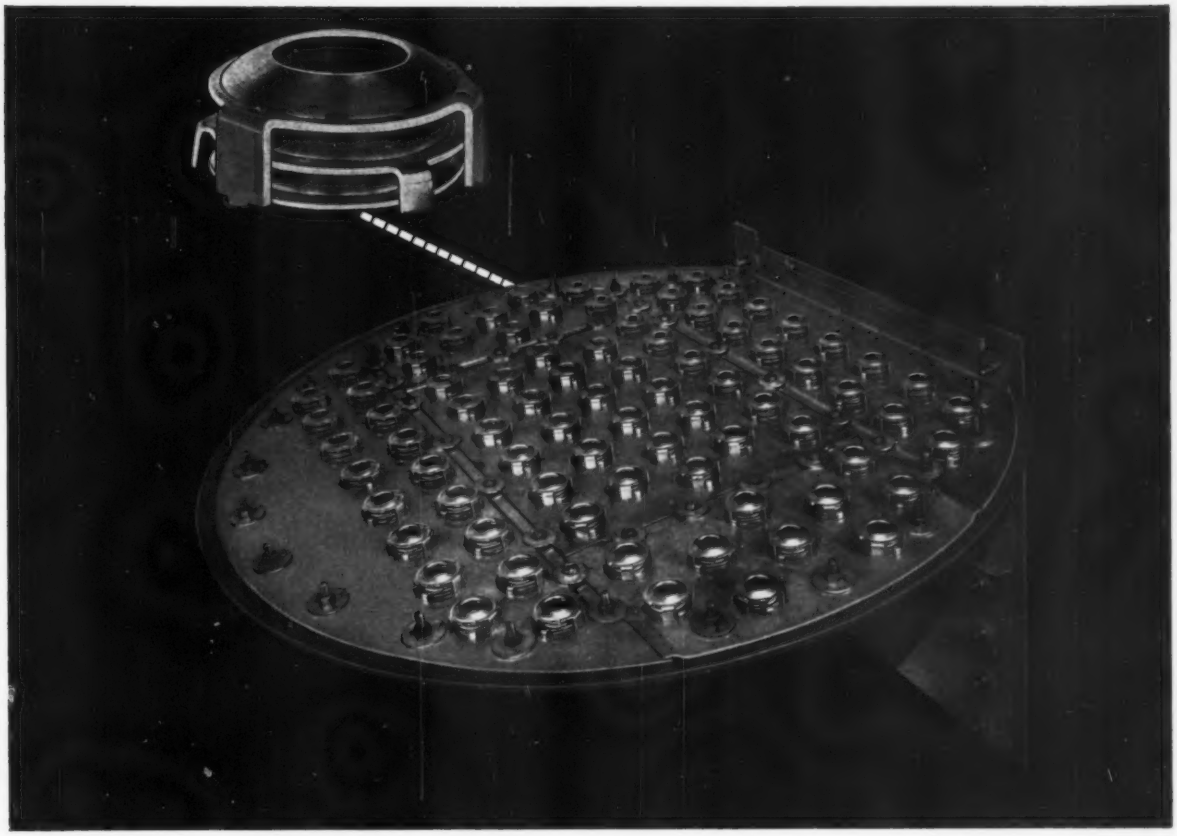
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Apache Powder	Curtis, Ariz.	*Ammonia	30 tons		Complete			Girdler	Girdler
Carter Oil	Billings, Mont.	Exp. Crude Cap.	34,500 bbls	$1,500,000	Under Constr			Esso	Staff
		*Heavy Cat Naphtha Treater	2,000 bbls		Under Constr	1959	Howe-Baker	Staff	Staff
		*Light Cat Naphtha Treater	8,000 bbls						
El Paso Natural Gas Products	Jal, N. M.	*Exp. Gasoline Fractionation	1,000 Mmcf	$2,471,000	Engineering	July 1959		Delta	Delta
		Fractionation		$730,000	Engineering	Sept 1959		Stearns-Roger	
	San Juan, Utah	*Gasoline	1,500 Mmcf	$5,378,000	Planning			Fish	Fish
	Lincoln, Wyo.	*Gasoline	2,500 Mmcf	$6,600,000	Complete			Fluor	Fluor
Empire Pet.	Denver	*Vacuum Rerun	1,150 bbls		Under Constr	1959		Staff/Litwin	Staff
Pan American	Riverton, Wyo.	Gasoline		$1,000,000	Under Constr	April 1959		Olsen	Olsen
Southwestern Agro-chemical	Chandler, Ariz.	Ammonia Synthesis	60 tons	$5,000,000	Engineering	Jan. 1960			
Standard (Ind.)	Mandad, N. D.	*Gasoline	1,630 bbls						
Texaco	San Juan County, Utah	Gasoline							

West Coast

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
American Chem.	Watson, Cal.	*Chemical			Engineering	Late 1959		Braun	Braun
California Ammonia	Lathrop, Cal.	Ammonia Synthesis	100 tons	$5,000,000	Engineering	1959		Maceo	Maceo

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 211



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The Glitsch Ballast Tray is a new type valve tray that has all the good features both of conventional bubble cap trays and perforated trays, and yet eliminates the many inherent problems encountered with ordinary valve type trays.

Data secured during operational runs to determine the efficiency of the new Glitsch Ballast Tray established the following: (1) The efficiency of the tray from very low vapor rates (within ten per cent of flood point) up to moderate vapor rates is higher than any other tray of comparable capacity; (2) the turndown ratio of the Glitsch Ballast Tray (the ratio of maximum to minimum vapor rates at which a high efficiency is maintained) is at least 9.0.

The Glitsch ballast unit is designed to function as a variable orifice and thereby provide a staging of the vapor through the various rates of flow. This design permits uniform distribution of vapor through the liquid throughout a wide range of capacity; optimum vapor velocity through the liquid over a wide range of flow rates; large turndown ratio by progressive staging of the vapor opening from low to increasingly high fluid rates, and establishes a primary pressure drop at the vapor-liquid interface to obtain maximum tray efficiency.

Increase the efficiency of your next distillation units. Specify new Glitsch Ballast Trays. For more information and operating data on the ballast tray, contact your nearest Glitsch sales representative or Glitsch — Dallas, Texas.

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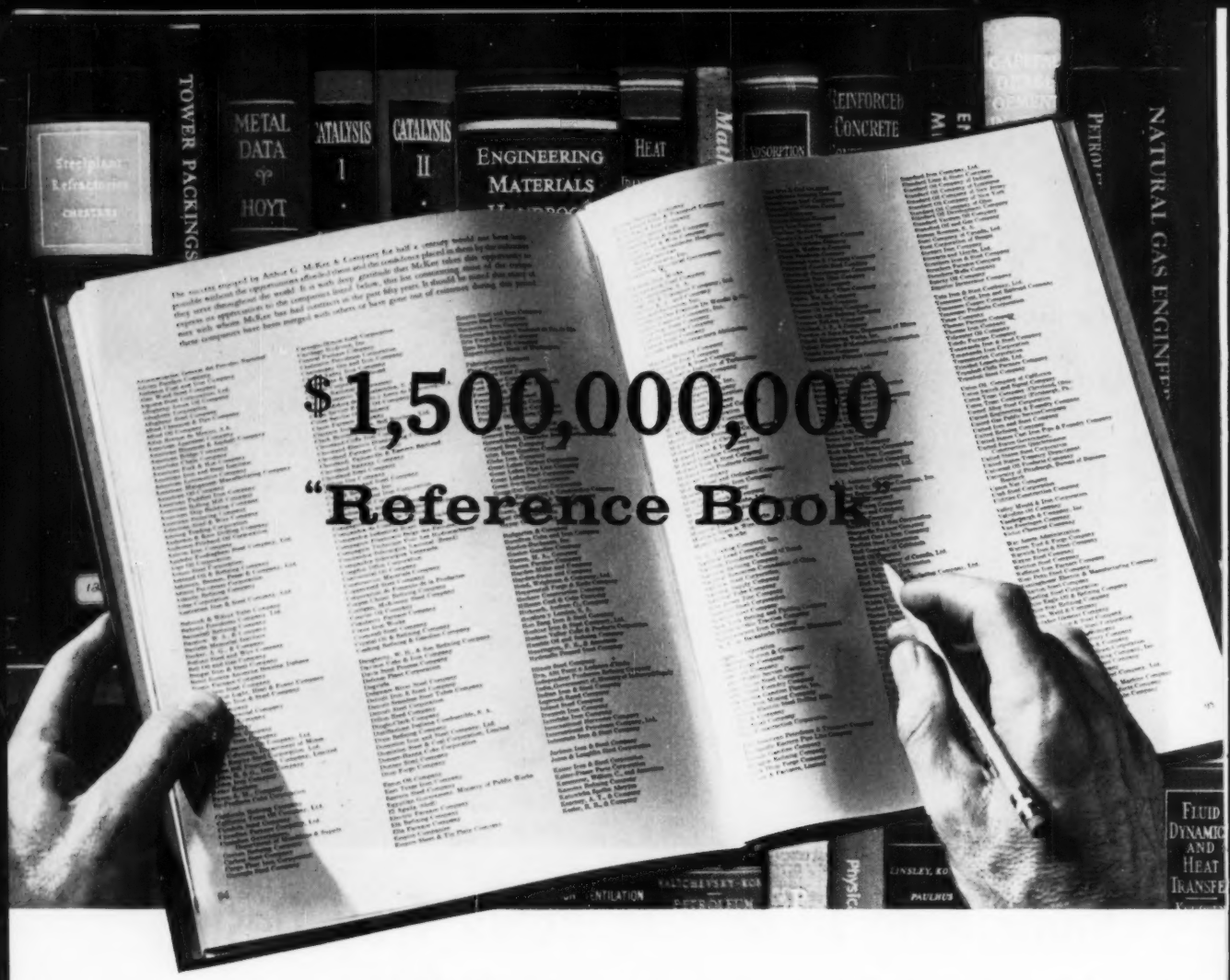

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McKEE ENGINEERING AND CONSTRUCTION SERVICES

CONSTRUCTION BOX SCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Collier Carbon & Chemical	Brea, Cal.	*Exp.				Mid 1959		Braun	Erhart
du Pont	Antioch, Cal.	Fluorinated Hydrocarbons, Tetraethyl Lead			Under Constr				
Fletcher Oil	Wilmington, Cal.	Unifiner Platformer			Under Constr		UOP	Parsons	Parsons
General Petroleum	Torrance, Cal.	*Exp. Fluid Coking			Planning				
		*Cat Reformer Revamp			Engineering	Mid 1959		Braun	Braun
Hancock, Oil	Long Beach, Cal.	Rebuild Refinery			Planning	1960		Nofsinger	Nofsinger
Vally Nitrogen	Cal.	Ammonia	150 tons		Engineering	1959	Chemico	Chemico	Chemico
Richfield Oil	Los Angeles	Benzene	18,000,000 gal/yr		Under Constr				
	Watson, Cal.	Crude Topping	37,000 bbls	$4,000,000	Under Constr	Mid 1959		Parsons; Staff	Parsons
		*Gas & Cat Cracker Revamp			Engineering	Mid 1959		Braun	Braun
Shell Chemical	Dominguez, Cal.	Exp. Isopropyl Alcohol			Complete				
	Torrance, Cal.	*Polyisoprene	5 tons		Complete				
Shell Development	Emeryville, Cal.	Research Lab.		$500,000	Under Constr				
Shell Oil	Wilmington	Boiler for Cat Cracker	200,000 lbs	$1,000,000	Under Constr				
Standard Oil (Calif.)	El Segundo	Steam Generating	275,000 lbs/hr	$2,000,000	Engineering	July 1959		Fluor	Fluor
Standard (Calif.)	Richmond, Cal.	*FCC	40,000 bbls		Under Constr	July 1959		Fluor	Fluor
		*Butamer	2,000 bbls			June 1959		UOP	UOP
Texaco	Anacortes, Wash.	Refinery Fluid Cat Cracker Alkylation Reforming Polymerization Hydrotreating	40,000 bbls		Complete			Bechtel	Becthel
	Los Angeles	Udex	9,000 bbls		Under Constr	2nd Qtr. 1959		UOP	
Standard Oil (Calif.)	Honolulu	Refinery	35,000 bbls	$40,000,000	Under Constr	1961		Staff/Bechtel	Bechtel/Hawaiian Dredging
Wilshire	Norwalk, Cal.	*Crude Distillation Revamp			Engineering	Oct. 1959		Braun/UOP	

Canada

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
British American Oil	Clarkson, Ont.	Desulfurizer	8,000 bbls	$2,200,000	Under Constr	April 1959	Kellogg	Kellogg	Kellogg
		Compounding, Blending & Grease		$2,900,000	Under Constr			Nofsinger	
		*Cat Cracker Exp.	6,000 bbls	$1,500,000	Under Constr	July 1959		Kellogg	Kellogg
		*Alkylation	2,500 bbls		Engineering	May 1960	UOP	UOP	
		*Steam Generating Unit Dist.		$600,000	Under Constr	July 1959		Staff	Staff
	Moose Jaw, Sask.	Cat Reformer & HDS	5,400 bbls	$3,900,000	Under Constr		Atlantic	Lummus/Procon	Lummus/Procon
		Gas Splitter	7,000 bbls		Engineering		UOP	Lummus/Procon	Lummus/Procon
			7,000 bbls	$1,000,000	Under Constr			Procon	Procon
British Petroleum	Ville D'Anjou Near Montreal	Refinery	25,000 bbls	$30,000,000	Under Constr	Mid 1960			Lummus
		Cat Cracker	9,000 bbls						
		Platformer	6,000 bbls						
		Cat Hydrogenation	12,000 bbls						
		Cat Polymerization	700 bbls		Under Constr				
Canadian Export Gas & Oil	Calgary, Alb.	*Gas Liquid Recovery	22 Mmcf	$225,000	Complete				
Canadian Oil	Corunna, Ont.	Platformer Exp.	6,000 bbls		Complete		UOP	UOP	Catalytic
		Crude Distl.	20,000 bbls	$3,000,000	Engineering	1959		Kellogg	Kellogg
Canadian Petrofina	Montreal	Exp. Capacity	30,000 bbls	$3,000,000	Under Constr			Staff	Procon (Canada)
Canadian Industries,	Edmonton, Alb.	Exp. Polythene	40,000,000 lbs/yr		Under Constr	1959			Poole Constr
Cyanamid of Canada	Hamilton, Ont.	Urea; Ammonia			Engineering	1959		Chemico	Chemico
Devon-Palmer & Texas Gulf Sulfur	Calgary, Alb.	Sulfur Extraction	400 tons	$8,000,000	Planning	Mid 1959			
Dow Chemical (Canada)	Sarnia, Ont.	*Polyethylene						Catalytic	Catalytic
Imperial Oil	Sarnia	Refinery Exp.	94,000 bbls	$5,360,000	Under Constr	Summer 1959		Staff	Staff
	Edmonton, Alb.	Asphalt	1,000 bbls	$980,000	Complete			Staff	Foster Wheeler
		*Alkylation	1,500 bbls.	$2,400,000	Engineering	Spring 1960			
	Calgary	Crude Cap.	14,700 bbls						
		Cat Cracker	7,000 bbls	$16,400,000	Under Constr	July 1959		Canadian Bechtel/Staff	Canadian Bechtel
		Powerformer	3,000 bbls						
		Offsite Facilities							
	Regina	Powerformer	2,500 bbls	$2,550,000	Under Constr	Faff 1959		Canadian Kellogg	Canadian Kellogg
	Winnipeg	Alkylation	740 bbls	$2,600,000	Under Constr	Sept. 1959		Canadian Bechtel	Canadian Bechtel
Irying Refining	St. John, New Brunswick	Hydrogen			Engineering	1960		Girdler Bechtel	Canadian Bechtel
		*Crude Desalter	38,500 bbls		Under Constr	Dec. 1959	Howe-Baker	Bechtel	Bechtel
Nevis Operators Committee	Nevis, Alb.	*Gas Processing	43 Mmcf	$3,000,000	Engineering			Fluor	Fluor
		*Sulfur Recovery	125 tons						
Noltingham Gas Carnduff Gas	Saskatchewan	*Gas Processing Treating, Gathering	8.5 Mmcf		Engineering	1959		Tellepsen	Tellepsen
Shell Oil (Canada)	Bronte, Ont.	Refinery			Planning			Treco/Staff	
	Vancouver	Solvent	750 bbls	$600,000	Complete			Fluor/Staff	Staff
		*Distl. Hydrodesulfurizer	9,300 bbls	$2,000,000	Complete			Fluor/Staff	Fluor
Steelman Gas	Southeast Saskatchewan	Natural Gas	25 Mmcf	$6,500,000	Under Constr			Stearns-Roger	Treco
Texas Eastman	Okotoks, Alb.	*Sulfur Recovery, Gas Processing	370 tons	$6,700,00	Under Constr	May 1959		B & R	B & R
Texas Gulf	Calgary, Alb.	*Sour Gas Recovery	100,000 tons/yr		Under Constr	Mid 1959		Shell/Devon Palmer	Shell/Devon Palmer
Wainwright Producers & Refiners	Wainwright, Alb.	*Visbreaker			Complete			Litwin	Litwin
Westcoast Transmission	Coleman, Alb.	Gas Processing		$15,000,000	Planning				

Latin America

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
ARGENTINA									
Argentine Government	Santa Fe Province	Naphtha Reforming			Planning				
Carbometal	Mendoza	Polyvinyl Choride	4,500 tons/yr						
		Acetylene	200 tons/yr						
		Plastics	7,500 tons/yr		Planning		Monsanto	Monsanto	Monsanto

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 212

CONSTRUCTION BOX SCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
BRAZIL									
Alba (Borden)	Cubatao	Methanol, Formaldehyde, Synthetic Resins	30 tons	$4,600,000	Under Constr	.....	Vulcan Texaco Fisher	Vulcan Girdler	Staff Girdler Austin; Montreal, SA
Empresa Colombiana de Petroleos	El Centro	Nat. Gasoline	51.4 Mmcf	$2,700,000	Under Constr	October 1959	.....	Parsons	Parsons
North American Solvay	Sao Paulo	Ethylene Purification	20 tons	.....	Under Constr	Mid 1959	.....	Hydrocarbon	Hydrocarbon/ SETAL
Petroleo Brasileiro	Mataripe	Atmospheric & Vacuum Distl. Cat Cracker Gas Recovery, Wax Treating, Lube	.....	.....	Under Constr	1960	Kellogg	Kellogg	Kellogg/Brasileira/Montreal, S A
	Rio de Janeiro	Refinery	90,000 bbls	$60,000,000	Under Constr	Early 1960	.....	Foster Wheeler	.....
	South Brazil	Refinery	70,000 bbls	.....	Planning	.....	.....	.....	.....
Uhde	Cubatao	Urea	.....	.....	.....	.....	.....	Uhde	Uhde
Union Carbide	Cubatao	Polyethylene	.....	.....	Under Constr	.....	.....	B & R	B & R
CHILE									
Empresa Nacional del Petroleo	Concon	Refinery Exp:							
		Crude Topping	24,000 bbls						
		Vacuum	10,080 bbls						
		Orthoflow FCC	12,000 bbls	$15,000,000	Under Constr	Early 1960	Kellogg	Kellogg	Staff & Kellogg
		SBK Cat Reforming and Desulfurization	6,000 bbls						
		Alkylation	1,100 bbls						
COLOMBIA									
Empresa Colombiana de Petroleos	Barranca-Bermeja	Exp. Propane Recovery	1,000 bbls	$1,000,000	Planning	.....	.....	.....	.....
ECUADOR									
Anglo-Ecuadorian Oilfields	Santa Elena Ancon	Atomspheric Distl.	7,700 bbls	$4,500,000	Under Constr	.....	UOP	Procon	Procon
		Thermal Cracking	6,000 bbls	.....	Under Constr	.....	UOP	Procon	Procon
MEXICO									
Pemex	Atzcapotzalco	Refinery	20,000 bbls	$20,000,000	.....	.....	.....	.....	.....
	Ciudad Madero	Topping	100,000 bbls						
		Cat Cracking	25,000 bbls						
		Gas Concentration; HF Alkylation; Polymerization; Sulfur		$25,700,000	Under Constr	Late 1959	Phillips/ Esso/ UOP	McKee	Staff
	Salamanca	Grease	25 tons	$1,700,000	Engineering	.....	.....	McKee	Staff
		Cat Cracker	15,000 bbls	.....	Planning	.....	.....	.....	.....
NETHERLANDS ANTILLES									
Largo Oil & Transport	Aruba, N. A.	Revamp Distl. & Visbreaking	.....	.....	Engineering	Nov. 1959	.....	Kellogg	Kellogg
PANAMA									
Refiner a Petroquimica de Panama	Portobelo	Refinery	55,000 bbls	$40,000,000	Engineering	1961	.....	Foster Wheeler	Foster Wheeler
Refineria Panama, S A	Las Minas Bay Colon	Refinery; Petrochemicals	70,000 bbls	$59,000,000	Under Constr	Late 1960	.....	Kellogg	.....
PARAGUAY									
Compagnie Fives-Lille	Asuncion, Paraguay	Refinery	10,000 bbls	.....	Planning	.....	.....	.....	.....
PUERTO RICO									
Commonwealth Oil Refining	Guayanilla Bay	Visbreaker	20,000 bbls	$2,700,000	Complete	.....	.....	Lummus	Lummus
		Unifiner	6,500 bbls	$1,200,000	Under Constr	Early 1959	UOP	Howe-Baker	Procon
		Gasoline	2,000 bbls	.....	Under Constr	Early 1959	Howe-Baker	Howe-Baker	Procon
		Ref. Modifications	75,000 bbls	$6,300,000	Under Constr	Early 1959	.....	UOP	Procon-Others
	Ponce	*Electrostatic Desulfurization	2,000 bbls	.....	Under Constr	1959	Howe-Baker	Lacer	Procon
Union Carbide Caribe	Ponce	Ethylene-Glycol	500,000 lbs	$28,500,000	Planning	Early 1959	.....	B & R	B & R
TRINIDAD									
Federation Chemicals,	Point Lisas	Nitrogen	100 tons	$12,000,000	Under Constr	Fall 1959	Kellogg	Braun/Kellogg	Braun
		Urea	70 tons	.....	.....	.....	Monsanto,	.....	.....
		Ammonia	100 tons	.....	.....	.....	.....	.....	.....
		Sulfuric Acid	200 tons	.....	.....	.....	Stamicarbon	.....	.....
		Ammonium Sulfate	245 tons	.....	Under Constr	1959	.....	Braun/Kellogg	Braun/Kellogg
Trinidad Oil Co.	Pointe-a-Pierre	Crude Distl.	15,000 bbls	.....	Under Constr	.....	UOP	Procon	Procon
URUGUAY									
Administracion	Montevideo	Crude Desalter	28,000 bbls	$12,000,000	Under Constr	Late 1959	Howe-Baker	Kellogg/Staff	
Nacional de Combustibles Alcohol Y Portland		Vac. Distl.	10,000 bbls	.....	.....	.....	.....		
		Cat Cracker	5,000 bbls	.....	.....	.....	.....		
		Cat Reformer	3,000 bbls	.....	.....	.....	.....		
		Gas Concent. & Bottling	.....	.....	.....	.....	.....	Kellogg-/Staff	Staff
		Gas Sweetening	4,500 bbls	.....	.....	.....	.....		
		Sulfur Recovery	6 tons	.....	.....	.....	.....		
		Power & Offsite Facil.	3,600 KW	.....	.....	.....	.....		
VENEZUELA									
Cia Shell	Cardon	Distl.	80,000 bbls	$20,000,000	Under Constr	.....	.....	.....	.....
		Alkylation	2,800 bbls	.....	Under Constr	.....	.....	.....	.....
	La Paz, Maracaibo	Exp. Compressor	.....	.....	Under Constr	May 1959	.....	Lummus	Lummus
Creole Pet.	Amuay Bay	Naphtha Fractionator	45,000 bbls	$3,600,000	Under Constr	1959	.....	Esso	Lummus
Socony Mobil	El Palito	Refinery	40,000 bbls	$28,000,000	Under Constr	Late 1959	.....	Kellogg	Kellogg
Venezuela Gulf Refg.	Puerto la Cruz	Crude Distl.	65,000 bbls	.....	Engineering & Constr	Late 1959	.....	Foster Wheeler	Foster Wheeler

Europe and Africa

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
AUSTRIA									
Austrian Oil Administration	Schwechat near Vienna	Crude Distl. Cat Reformer, Gas Recovery, Chemical	35,000 bbls 7,000 bbls	$22,300,000	Engineering	Late 1959	.....	Lurgi	Lurgi
Danubia Petrochemie A. G.	Schwechat near Vienna	Polypropylene	11,000,000 lbs/yr	.....	.....	.....	.....	.....	.....
BELGIUM									
Cobenam, S.A.	Antwerp	*Polyethylene	15,000 tons/yr	.....	Planning	Mid 1960	.....	Union Carbide	Union Carbide
CANARY ISLANDS									
Cepsa	Las Palmas	Ammonia	90 tons	.....	Engineering	.....	Hoechst	Uhde	Uhde
		*Ammonium Sulfate	365 tons	.....	Enginering	Mid 1960	Uhde-Texaco	Uhde	Uhde
ENGLAND									
British Petroleum	Kent	Hydrofiner II	10,000 bbls	.....	Under Constr	.....	.....	Kellogg	McAlpine, Wimpey
		Udex	500 bbls	.....	Under Constr	.....	.....	UOP/Badger Mfg	McAlpine, Wimpey
		*Thermal Reformer	12,000 bbls	.....	Complete	.....	.....	Kellogg	Kellogg

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 215

Complete SCOPE of
WATER CONDITIONING
SERVICE from...

ALLIS-CHALMERS

End algae problems

easy, low-cost way

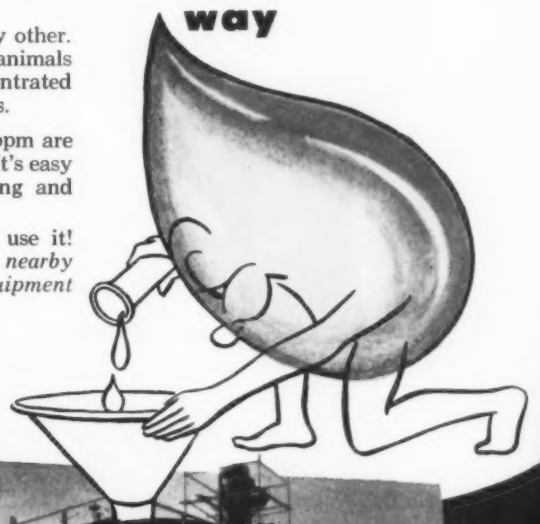
Eliminate problems of plugged pump strainers, coated heat-exchanger tubes and coated slots in cooling towers.

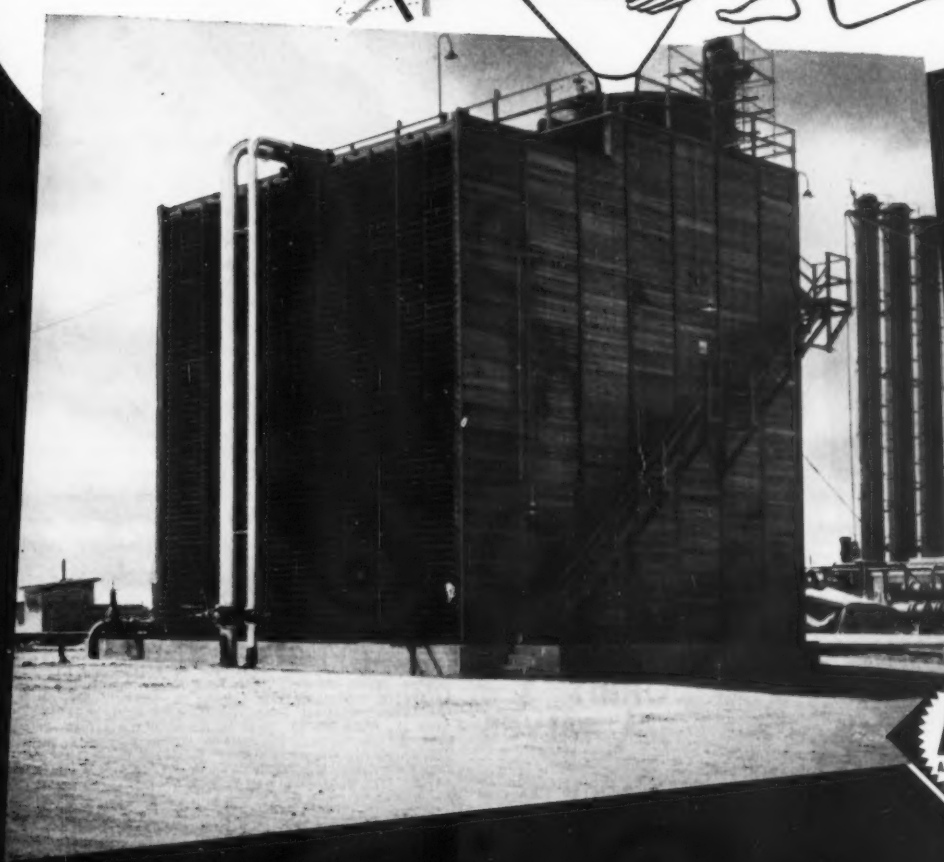
Control is safe . . . quick with Allis-Chalmers No. 120 Series Algaecide.

This algaecide is toxic to more algae than any other. On the other hand, it has low toxicity to fish or animals and is extremely safe to handle. Even in concentrated form it is only a mild irritant to skin and hands.

A little goes a long way! Only 2 to 5 ppm are required for effective dosage of most organisms. It's easy to feed into the system . . . and is non-oxidizing and corrosion inhibiting.

No water conditioning specialist needed to use it! Buy it and try it. *Purchase directly from your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.*





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ORBIT non-lubricated forged steel valves for minimum maintenance

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WRITE FOR:
CATALOG 58-B *covering our line of ASA class valves — full round and venturi openings.*

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For more data on advertised products, use Readers' Service Cards, last page.

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Courtlands	Spondon	*Exp. Refinery	.....	.....	Under Constr	Early 1960	.....	.....	.....
Esso Petroleum	Fawley	Steam Cracker Butene Dehydrogenation Ethylene Recovery Butadiene Extraction	40,000 lt tons/yr	$27,000,000	Under Constr	.....	.....	Foster Wheeler	Foster Wheeler
		Powerformer	21,000 bbls	$12,000,000	Under Constr	Early 1959	.....	Lummus	Lummus
		Sulfur	60 tons	$700,000	Under Constr	.....	.....	Foster Wheeler	Foster Wheeler
	Milford Haven	Refinery	100,000 bbls	$52,000,000	Planning	Early 1960	.....	.....	.....
Imperial Chemical Industries	Billingham	*Electrostatic Desulfurization	1,150 bbls	.....	Under Constr	July 1959	Howe-Baker	Kellogg	Kellogg
Malta Gas Board	Valetta	Catalytic Oil Gasification	1 Mmcf	.....	Under Constr	Early 1959	.....	Power Gas	Power Gas
Mobil Oil Co., Ltd.	Coryton	Cat Hydrodesulfurization	.....	.....	Pre-engineering	.....	.....	.....	.....
		Crude Unit Exp.	5,000 bbls	.....	Under Constr	.....	.....	Staff	Staff
Monsanto	Newport	*Maleic Anhydride	15,000,000 lbs/yr	.....	Under Constr	Late 1960	SD	SD	SD
North Thames Gas Board	Romford	Refinery Tail Gas Reforming	36 Mmcf	.....	Under Constr	.....	.....	H & G	H & G
North Western Gas Board	Manchester	Pressure Oil Gasification	7.5 Mmscf	.....	Engineering	Dec. 1959	Texaco/ others	H & G	H & G
Petrochemicals	Partington, Nr. Manchester	Exp. Ethylene	30,000 tons/yr	.....	Engineering	.....	.....	H W P	H W P
	Partington	Ethylene Oxide	25,000 tons/yr	.....	.....	.....	.....	.....	.....
Shell Refining	Shell Haven	Hydrodesulfurizer & Gerbotol Modifications	.....	.....	Under Constr	Spring 1959	.....	Lummus	Lummus
		Hydrodesulfurizer	16,000 bbls	.....	Projected	1960	.....	.....	.....
	Stanlow	Udex	.....	.....	.....	.....	UOP	.....	.....
South Eastern Gas Board	Isle of Grain	Cat Oil Gasification	15 Mmcf	.....	Under Constr	.....	.....	Power Gas	Power Gas
Southern Gas Board	Southampton	Refinery Tail Gas Reforming	16 Mmcf	.....	Under Constr	.....	.....	H & G	H & G
	Reading	Catalytic Oil Gasification	7 Mmcf	.....	Under Constr	Early 1959	.....	Power Gas	Power Gas
FRANCE									
Compagnie de Raffinage Shell Berre	Petit Couronne	Distl.	80,000 bbls	.....	Under Constr	.....	.....	.....	.....
		Hydrodesulfurizer	11,000 bbls	.....	Under Constr	4th Qtr. 1959	.....	.....	.....
		Platformer	14,000 bbls	.....	Engineering	1959	.....	Procon	Procon
	Berre	*Furfural	3,500 bbls	.....	.....	.....	.....	Foster Wheeler	Foster Wheeler
Comp Francaise de Raffinage	Martigues	Powerformer	20,000 bbls	.....	Complete	.....	.....	Foster Wheeler	Foster Wheeler
	Gonfreville l'Orcher	Ethylene	30,000 tons/yr	.....	Under Constr	Early 1959	.....	KIC	.....
Compagnie Francaise de Petrole; Compagnie Francaise de Raffinage; Pechelbronn, Socantar	Strasbourg	Refinery	70,000 bbls	.....	Planning	.....	.....	.....	.....
Lorraine-Kuhlmann	Dieuze (Moselle)	*Polystyrene	.....	.....	Complete	.....	Koppers	Kuhlman	.....
Naphtachimie	Laverna	Ethylene Oxide Exp.	31,000,000 lbs/yr	.....	Engineering	.....	SD	SFST	SFST
		*Expand Ethylene Oxide	31,000 lbs/yr	.....	Engineering	1960	SD	SFST	SFST
Esso Standard	Gironde Bordeaux	Refinery	31,500 bbls Expandable to 45,000 bbls	.....	Complete	.....	Esso	Lummus	Lummus
	Port Jerome	Powerformer	11,900 bbls	.....	Under Constr	.....	Esso	Foster Wheeler	Foster Wheeler
		Steam Cracker	5,000 bbls	.....	Under Constr	1959	Esso	Foster Wheeler	Foster Wheeler
		Dodecylbenzene	13,500,000 tons/yr	.....	Under Study	.....	Esso	Foster Wheeler	Foster Wheeler
Houilleres du Bassin de Lorraine	Carling	Acetylene	.....	.....	Under Constr	.....	Koppers	SBA	SBA
		Styrene Monomer	.....	.....	Under Constr	Early 1959	.....	SBA	SBA
Manufacture Normande de Polyethylene	Gonfreville	Polyethylene	.....	.....	Under Constr	.....	Phillips	.....	S T E C
Marles-Kuhlmann	Gonfreville	Ethylene Oxide	.....	.....	Under Constr	.....	S D	Staff	.....
Mobil Oil Francaise	Gravenchon	Lube Exp.	.....	.....	Engineering 2nd phase	.....	.....	.....	.....
			.....	.....	Planning 3rd phase	1959	.....	.....	.....
Napthachemie	Lavera	Ethylene	30,000 tons/yr	.....	Under Constr	1960	.....	S & W Ltd	S & W Ltd
Omnium Francais de Petroles		Refinery	75,000 bbls	.....	Planning	.....	.....	.....	.....
Potasse et Engrais Chimiques	Grand Couronne	Ammonia	.....	.....	.....	.....	.....	Kellogg	Kellogg
Societe des Produits d'Aquitaine	.....	Ammonia	200 tons	$6,000,000	Engineering	1959	.....	Chemico	Chemico
	Lacq	Acetylene from Nat. Gas	75 tons	.....	Under Constr	.....	.....	BASF	.....
Societe du Caoutchouc Butyl	Port Jerome	Butyl Rubber	20,000 tons/yr	.....	Under Constr	Early 1959	Esso	Braun	Braun
Soc. Francaise des Petroles BP	Dunkirk	Cat Reformer	10,000 bbls	.....	Under Constr	.....	.....	UOP/Kellogg	.....
Soc. Nationale des Petroles D'Aquitaine	Lacq	Desulfurization	140 Mmcf	.....	Under Constr	.....	.....	Foster Wheeler Soc Chimique/	Foster Wheeler Soc Chimique
		Desulfurization	175 Mmcf	.....	Engineering	1959	.....	Foster Wheeler Soc Chimique/	Foster Wheeler Soc Chimique
		Distillation Recovery II	112 Mmcf	.....	Under Constr	1959	.....	Hydrocarbon/ Lummus/	Hydrocarbon/ Lummus/
		Sulfur Recovery Phase II	970 tons	.....	Under Constr	.....	Parsons	Parsons/Heurtey	Parsons/Heurtey
		Sulfur Recovery Phase III	780 tons	$22,000,000	Engineering	1959	Parsons	Heurtey Parsons & Heurtey	Heurtey Parsons & Heurtey
		Sulfur Recovery Phase IV	1,000 tons	.....	Engineering	1961	Parsons	Parsons & Heurtey	Parsons & Heurtey
		Ethylene	25,000 tons/yr	.....	Engineering	1960	.....	Hydrocarbon	Staff
EAST GERMANY									
Ministry of Coal & Energy	Rostock	Catalytic Oil Gasification	2.4 Mmcf	.....	Under Constr	.....	.....	Power Gas/ Didier	Power Gas/ Didier
WEST GERMANY									
B.P. Benzin und Pet	Dinslaken	Refinery	100,000 bbls	.....	Under Constr	1960	.....	Kellogg	.....
		Chemical	.....	.....	Engineering	1959	.....	S & W	S & W
		Ethylene	.....	.....	Engineering	1959	.....	S & W	S & W
Buna Werke Huels	Marl, Kreis Recklinghausen	Synthetic Rubber	45,000 tons/yr	$37,000,000	Under Constr	.....	Esso; R & E Houdry; Firestone	Staff	Staff
Chemische Fabrik Holten	Lubwigshaven a Rein	Ethylene Oxide	9,000,000 lbs/yr	.....	Under Constr	.....	S D	S D	.....
Chemische Werke Huls	Marl	Polyethylene	6,000 tons/yr	.....	Planning	Summer 1959	Ziegler	Staff	Staff
Durag-Nerag	Misburg, Hannover	*Platformer, Sulfur Recovery	4,500 bbls.	.....	Engineering	July 1960	UOP	Lurgi	.....
Deutsche Erdoel	Heide/Holstein	Propane-Propylene Separation	7,000 tons/yr	.....	Complete	.....	Calif. Res. Hydrocarbon	Hydrocarbon/ Hydro M	Staff
Deutsche Shell	Harburg	Refinery with Crude Distiller Cat Reformer Hydrodesulfurization	40,000 bbls	.....	Under Constr	.....	.....	.....	.....
	Godorf	Refinery	30,000 bbls	.....	Under Constr	1960	.....	.....	.....

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 216

CONSTRUCTION BOX SCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Erdolchemie	Dormagen (Nierderrnein)	Gasoline	65,000 tons/yr		Under Constr		Lurgi/ S D	Lurgi/S D	
		*Petrochemical		$70,000,000	Under Constr				
		Platformer	6,700 bbls		Under Constr		UOP	UOP Procon	Procon
		Two Distl.	50,000 bbls each		Under Const				
		Cat Reformer	12,500 bbls		Under Constr				
		Hydrofiner	10,000 bbls		Under Constr				
		Copper Chloride Treaters	2,400 bbls each		Under Constr				
Esso	Cologne	Refinery	72,000 bbls	$41,000,000	Complete		Esso		Braun & Others
		Atmospheric Crude Distl			Complete			Braun, Uhde	Braun
		Powerformer	9,000 bbls		Complete			Lurgi	
		Hydrofiners	14,700 bbls		Complete			G H H	Esso
		Steam Cracker	5,600 bbls		Under Constr	Summer 1959		Kocks Still	
		Sulfur Recovery	8,900 tons/yr		Complete				
	Hamburg	Oil Sweetening	6,300 bbls		Under Constr	July 1959	Esso	Lurgi	
		Solvents Hydrofiner	3,040 bbls		Under Constr	May 1959	Esso	Lurgi	
Feldmuhle	Lulsdorf	Ethylene	10,000 tons/yr		Engineering			Hydrocarbon Hydro M	Hydro M
Gewerkschaft Erdol-raffinerie Emsland	Lingen Holt-hausen	*Crude	32,000 bbls		Under Constr	Early 1960		Lurgi	Lurgi
		Kerosine Desulfurization	270 tons		Under Constr	Early 1960		Lurgi	Lurgi
		*Gasoline Desulfurnization	207 tons		Under Constr	Early 1960		Lurgi	Lurgi
Frisia	Emden	Refinery	30,000 bbls	$17,000,000	Engineering	1959		Parsons	Parsons
Mobil Oil A. G.	Bremen-Oslebhausen	Crude, Two Stage	16,000 bbls		Complete			Hydrocarbon Hydro M	Hydro M
Purfina Mineralol-raffinerie	Duisburg	Topping, Platformer Hydro-desulfurizer	20,000 bbls		Under Constr	Late 1959	UOP, Shell	Lummus/Uhde	Lummus/Uhde
Rheinische Olefinwerke	Wesseling Bez. Koln	Polyethyene			Under Constr	Mid 1959	Phillips	Braun/Staff	
		Ethylene			Under Constr		Kellogg	Lurgi	
Ruhrchemie	Oberhausen-Holten	*Platformer	2,000 bbls		Under Constr	Jan. 1960	UOP	Procon	Procon
		*Unifiner	2,900 bbls		Under Constr	Jan. 1960	UOP	Procon	Procon
Westdeutsch Erdolleitungs	Ruhlermoor	*Crude Desalter	5,700 bbls		Engineering	Summer 1959	Howe-Baker	Uhde	Dortmund
GREECE									
Greek Government	Ptolemaeus, Greece	*Ammonia *Ammonium Sulfate *Ammonium Nitrate	300 tons 525 tons 325 tons		Engineering	Mid 1962	Uhde, Casale	Uhde, Casale	Uhde, Casale
IRELAND									
Irish Refining	Whitegate	Refinery	32,000 bbls	$33,600,000	Approved	1959			
Esso Petr. (Ireland) Caltex (Ireland) Shell Mex., B. P.			30,000 bbls		Under Constr	Summer 1959			Lummus
ITALY									
Aziende Colori Nazionali Affini	Milan	*Phthalic Anhydride	10,000 tons/yr		Engineering	Late 1959	Monte-catini	Badger Mfg	Badger Mfg
Asfalti Bitumi Cementic Derivati, S.A.	Ragusa	Polyethylene	25 tons		Under Constr			BASF	
Azienda Nazionale Idrogenazione Combustibil	Ravenna	Styrene Monomer	14,000 tons/yr		Under Constr		Koppers	SBA	SBA
		Butadiene	22,000 tons/yr		Engineering	Fall 1959	Houdry	Catalytic	
		Ethylene			Under Constr		Koppers	ANIC	
Distilleria Italiana	Milan	Butanol	11,000 tons/yr		Engineering		Hoechst	Uhde	Uhde
Ftalital, S.p.a.	Italy	Maleic Anhydride	2,200,000 lb/yr		Engineering		S D	S D	
I.R.O.M.	Venice	Hydrofiner	6,500 bbls		Engineering	1959		SNAM	SNAM
Mobil Oil Italiana	Naples	Cat Reforming	9,000 bbls		Under Constr			CTIP	CTIP
		Cat Hydrodesulfurization	10,000 bbls		Under Constr			CTIP	CTIP
		Lube Exp.			Under Constr			Staff	Staff
Montecatini Societe Generale per l'Industria Mineraria Chimica	Ferrara	Exp. Polypropylene			Planning	1959			
	Castellanza	Exp. Formaldehyde	135,000,000 lbs/yr	$300,000	Under Constr				
	Brindisi	*Petrochemical	700,000 tons/yr	$95,000,000	Under Constr	1962			
Sincat	Priolo, Sicily	Ammonia	150 tons					Foster Wheeler	Foster Wheeler
		Ethylene			Engineering	1959	S & W	S & W	
		Treating			Engineering	1959		S & W	
Snia Viscosa	Varedo, near Milan	Carbon Disulfide			Under Constr	1960	Food		
Wtanic Petrolifera	Livorno	*Naphtha Stabilizer and Splitter	11,000 bbls	$720,000	Engineering	Late 1959		Esso	CTIP
Union Carbide Societa Edison S.A.	Sicily	*Polyethylene	15,000 tons/yr		Under Constr	1959			
NETHERLANDS									
B. F. Goodrich & Algemene Kunstzijde Unie	Arnheim	Butadiene				Mid 1959			
Kunstzijde Unie N.V.		Styrene							
Esso Nederland	Rotterdam	Refinery	95,000 bbls	$50,000,000	Under Constr	Early 1960	Esso	Badger N.V.	Badger N.V.
NORWAY									
Standard (N.J.)	Oslo Fjord	Refinery	40,000 bbls	$30,715,000	Engineering	Late 1960	Esso	Esso	
PORTUGAL									
Ammoniaco Portugues	Esterreja.	Ammonia	40 tons		Complete		Uhde	Uhde	Uhde
		*Ammonium Sulfate	220 tons						
Socedada Portuguesa de Petroquimica Sarl	Lisbon	*Ammonia	185 tons		Planning		Uhde-Texaco	Uhde-STEC	Uhde-STEC
		*Hydrogen	1.5 Mmcf						
		*Fuel Gas	11 Mmcf						
RUMANIA									
Maschimport		*Formaldehyde	100 tons					Uhde	Uhde
Rummanian Govt.	Teleajen	Lube Oil							
		Natural Gas Treating							
	Borzesti	Petrochemical							
	Onesti	Synthetic Rubber							
SCOTLAND									
British Hydrocarbon Chemicals	Grangemouth	Polyethylene	25,000,000 lbs/yr		Under Constr	Early 1959	Phillips	S & W	
		*Ethylene	70,000 tons/yr		Engineering	1960		S & W Ltd	S & W Ltd
		Cumene			Engineering	Mid 1959	Mid-Centry	S D S & W Ltd	S & W Ltd
		Phenol			Under Constr	1959	Distillers	S & W Ltd	S & W Ltd
British Petroleum	Grangemouth	Copper Chloride	2,000 bbls		Under Constr			Power Gas	Power Gas
		Kerosine Treating	2,000 bbls		Under Constr			Power Gas	Power Gas
		Deethanizer	625 bbls		Under Constr			Power Gas	Power Gas
SOUTH AFRICA									
Caltex	Durban	Refinery							
SPAIN									
Hidro Nitro Espanola	Monzon								
	Tarragona	Ammonia Synthesis	22 tons		Complete		Uhde	Uhde	Uhde
Refineria de Petroleos de Escombreras S.A.	Escombreras	*Ammonium Sulfate	88 tons		Complete			Uhde	Uhde, et al

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 219

Passes even the "white glove" inspection– Thanks to Dowell's new standard of cleanness

You may never have occasion to place "white glove" requirements to the cleanness of your process equipment, steam generators, tanks and piping. But, if you do need this high degree of cleanness, Dowell can now offer it — as an additional service — in the chemical cleaning of *your* plant equipment.

Dowell developed these new standards in cleaning the piping networks of the missile launching facilities at Cape Canaveral. Combining the research and engineering facilities of the entire company, Dowell perfected new techniques, materials and equipment to meet the necessary rigid specifications.

This new service is now adaptable for use in all types of American industry. For example, Dowell recently performed an intricate cleaning job on a 3½-mile-long buried pipeline. The customer wanted to convert the six-inch line from hydrocarbon gas to carry oxygen. For this pure product the line had to be immaculate—free of all foreign materials. The plant was faced with the alternate of laying new pipe—a six week job at a cost of $150,000.

Using their new standard of cleanness, Dowell cleaned the line of hydrocarbon residues, carbon black, grease, mill scale, and rust. Meanwhile, plant crews made mechanical alterations to the line at a cost of about $25,000. Dowell's charge was $20,000; the job was done in 3½ days.

The job was satisfactory in every way. Inspection showed the line was free of all foreign matter. The customer credited Dowell with saving them about $100,000. Also the plant made additional profits because the line was put back into use so quickly.

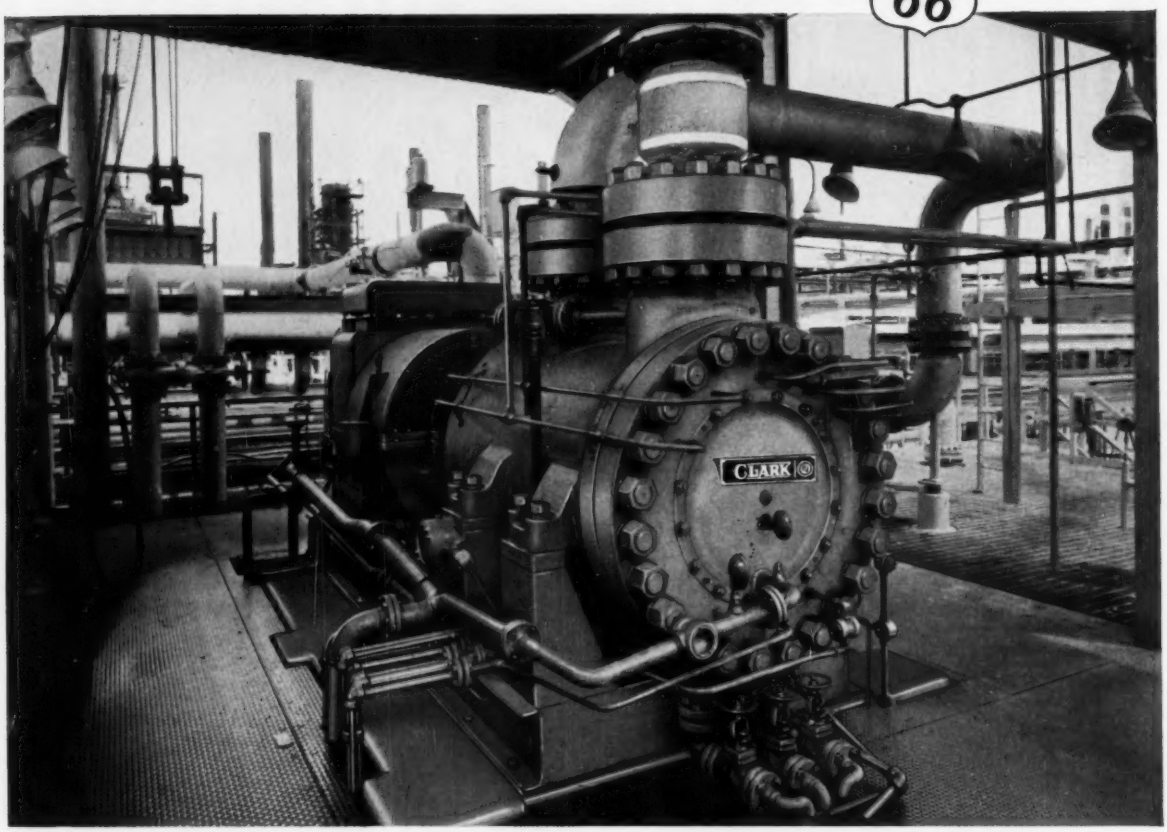
Ask your Dowell representative about these new standards of cleanness and their possible application to your problems. This exclusive Dowell service may save you important money. Dowell, the pioneer of chemical cleaning, has 165 offices to serve every major industrial center. Dowell, Tulsa 1, Oklahoma.

Chemical cleaning service for all industry DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

AT PHILLIPS PETROLEUM CO.



First full-scale PENTANE ISOMERIZATION plant uses Clark Barrel-Type Centrifugal Compressor

Isomerize normal pentane to permit the use of natural gasoline as a high octane blending stock? Why not, said Phillips Petroleum Company. Normal Pentane was one of the remaining major components of natural gasoline that could be upgraded. Furthermore, the low sensitivity of isopentane together with its high octane level made it an ideal blending agent in premium gasoline.

By-passing the usual prototype size unit, Phillips built the industry's first full scale pentane isomerization plant. The plant uses Universal Oil Products Company's Penex Process employing a platinum-containing catalyst. With a design capacity of 34,400 bbl. per day of pentane reactor feed, the plant can produce about 16,000 bbl. per day of 95% isopentane. Startup was smooth and design yields were quickly reached.

To handle the hydrogen recycle phase of the process at the Borger, Texas plant, a Clark Vertically-Split Multi-Stage Centrifugal Compressor was selected. While the ratio of hydrogen to hydrocarbon is low in this process, the high feed capacity requires 2,000 hp for hydrogen circulation. As in many other similar processes, the performance of this Clark compressor has from startup met the rigid design requirements.

CLARK®

For complete details on Clark Vertically-Split Compressors, write for Bulletin 150.

COMPRESSORS AND GAS TURBINES

CLARK BROS. CO., OLEAN, NEW YORK

For more data on advertised products, use Readers' Service Cards, last page.

CONSTRUCTION BOX SCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
SWEDEN									
A. Johnson & Co.	Sweden	Refinery Exp.	.....	.....	Under Constr	.....	.....	Bechtel	Bechtel
Stockholm Gas & Water Works	Stockholm	Cat Oil Gasification	4 Mmcf	.....	Under Constr	Mid 1959	Power Gas	.....	Power Gas
TURKEY									
Badische Anilin and Soda Fabrik	Kutahya	Ammonium Sulfate	60,000 tons/yr						
Mobil Overseas, Shell, Caltex BP	Mersin	Sulfuric, Nitric Acid Refinery	50,000 tons/yr 65,000 bbls	$20,000,000 $48,000,000	Under Constr Under Constr	.....	BASF	BASF	.....
Turkish Government	Istanbul	Natural Gasoline	.....	.....	Planning	.....	.....	.....	.....
UNION OF SOUTH AFRICA									
Standard-Vacuum	Durban	Refinery Exp. Powerformer Hydrofiner Steam	25,000 bbls	$9,000,000	Engineering	....	....	Foster Wheeler	Foster Wheeler ....
YOUGOSLAVIA									
Yougoslav Government	Sisak	Topping and Cat Reforming	15,000 bbls	$5,400,000	Planning	1963	.....	Inst. Pet., Zagreb	Staff
		Ammonia	120/tons	$11,000,000	Planning	1962	Foster Wheeler	.....	.....

Near East

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EGYPT									
Anglo-Egyptian Oilfields	Suez	Cat Reformer	2,300 bbls	.....	Projected	.....	.....	.....	.....
Egyptian Chem. Ind., KIMA S.A.E.	Aswan	Ammonia	315 tons	.....	Under Constr	1960	BASF	BASF	BASF
Egyptian Govt.	Suez	Power	10,000 KW	$2,200,000	Planned	1959	.....	.....	.....
		Atmos. Distl., Vac. Distl. & Lube Oils	20,000 bbls	$7,000,000	Planning	1960	.....	.....	.....
		Cat Reformer	3,000 bbls	$2,700,000	Planning	1962	.....	.....	.....
		Hydrodesulfurizer	2,700 bbls	$720,000	Planning	1962	.....	.....	.....
		Lube Oils	.....	$9,000,000	Planning	1963	.....	.....	.....
		Vapor Recovery & Bottling	70 tons	$1,000,000	Planned	1959	.....	Lummus	Lummus
	Alexandria	Atmos. & Vac., Distl.	10,000 bbls	$1,400,000	Planning	.....	.....	.....	.....
	Cairo	Atmos. Distl. & Vac., Distl.	10,000 bbls	$1,400,000	Planning	.....	.....	.....	.....
IRAN									
Iran Government	.....	*Nitrogen	30,000 tons/yr	$30,000,000	Planning	.....	Montecatini	.....	.....
IRAQ									
Iraq Government	Baghdad	Refinery Exp.	48,000 bbls	$11,000,000	Under Constr	July 1959	Esso	Foster Wheeler	Foster Wheeler
		Powerformer	5,000 bbls	.....	.....	Sept. 1959	.....	Foster Wheeler	Foster Wheeler
		Kerosine Treating	5,000 bbls	.....	.....	Sept. 1959	.....	Foster Wheeler	Foster Wheeler
	Qaiyarah	Refinery Revamp Crude Topping; Vacuum Distl.; Thermal Cracking Asphalt	7,500 bbls	.....	Planning	Late 1959	.....	.....	.....
ISRAEL									
Fertilizers & Chemicals	Haifa Bay	Ammonia Exp. Fertilizers	50 tons	$5,000,000	Engineering	1959	.....	.....	.....
KUWAIT									
Kuwait Oil	Mina al Ahmadi	Hydrobon Platformer	4,070 bbls	.....	Under Constr	Early 1959	UOP	Procon	Bechtel-Kuwait
		Prefractionator	7,200 bbls	.....	Under Constr	Early 1959	UOP	Procon	Bechtel-Kuwait
NEUTRAL ZONE									
Getty Oil Co.	Netral Zone	Crude Stripping	50,000 bbls	$2,000,000	Under Constr	.....	.....	Parsons	Parsons
PAKISTAN									
Pakistan Industrial Dev.	Fruchanj, Pakistan	Ammonia Urea	225 tons 375 tons	$20,000,000	Engineering	1961	Kobe Steel	Chemico	Chemico
SAUDI ARABIA									
Arabian American Oil	Ras Tanura	Alkylation	1,210 bbls	$6,990,000	Under Constr	Mid 1959	Kellogg	Kellogg/Staff	Staff
		LPG	1,500 bbls	$1,025,000	Engineering	1961	Kellogg	Staff	Staff
SYRIA									
Syrian Government	Homs	Refinery	20,000 bbls	$14,000,000	Planning	August 1959	Technoexport Prague	Technoexport Prague	Technoexport Prague

Far East

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
CHINA									
Hong Kong & China Gas	Hong Kong	Cat Oil Gasification	1.5 Mmcf	.....	Under Constr	Autumn 1959	Hercules	Power Gas	Power Gas
INDIA									
Alkali & Chemical of India	India	Polyethylene	.....	$6,300,000	Under Constr	Early 1959	I C I	.....	Simmon Carves
Indian Government	Asam	Refinery	15,000 bbls	$17,000,000	Under Constr	.....	.....	Rumanian Government	Rumanian Government
New Central Jute Mills	Varaussi	Ammonia	45 tons	.....	Under Constr	Late 1959	Uhde	Uhde	Uhde
Standard Vacuum	Bombay	Asphalt	125,000 tons/yr	$2,500,000	Under Constr	July 1959	.....	Parsons	Parsons
JAPAN									
Asahi-Dow	Kawasaki	Styrene Monomer	.....	.....	Under Constr	1960	Dow	Dow	Dow
Befu Chemical	Befu Harbor Honshu	Ammonia	.....	.....	Complete	.....	Texaco	Chemico	Chemico
Daikyo Oil	Yokkaichi	Topping & Vacuum	30,000 bbls	.....	Under Constr	Mid 1959	.....	J G C	J G C
Furukawa Chemical Industries	Japan	Polyethylene	.....	.....	Under Constr	Spring 1959	Standard (Ind.)	.....	.....
Idemitsu Kosan	Tokuyama	Unifiner	6,000 bbls	$1,450,000	Under Constr	.....	UOP	UOP; J G C	J G C
		*Topping	35,000 bbls	$4,000,000	Under Constr	May 1959	UOP	Fujinagata Shipyard	Fujinagata Shipyard
		*Platforming	7,000 bbls	.....	Planning	Mid 1960	UOP	.....	.....
Japan Synthetic Rubber	Yokkaichi	Butadiene & GR-S Rubber	45,000 tons/yr	$30,000,000	Under Constr	1959	Houdry Esso Goodyear	Blaw-Knox; Catalytic; Chiyoda	Chiyoda

* First appearance in tabulation.

Construction BOXSCORE Continued on Page 220

CONSTRUCTION BOX SCORE—*Continued*

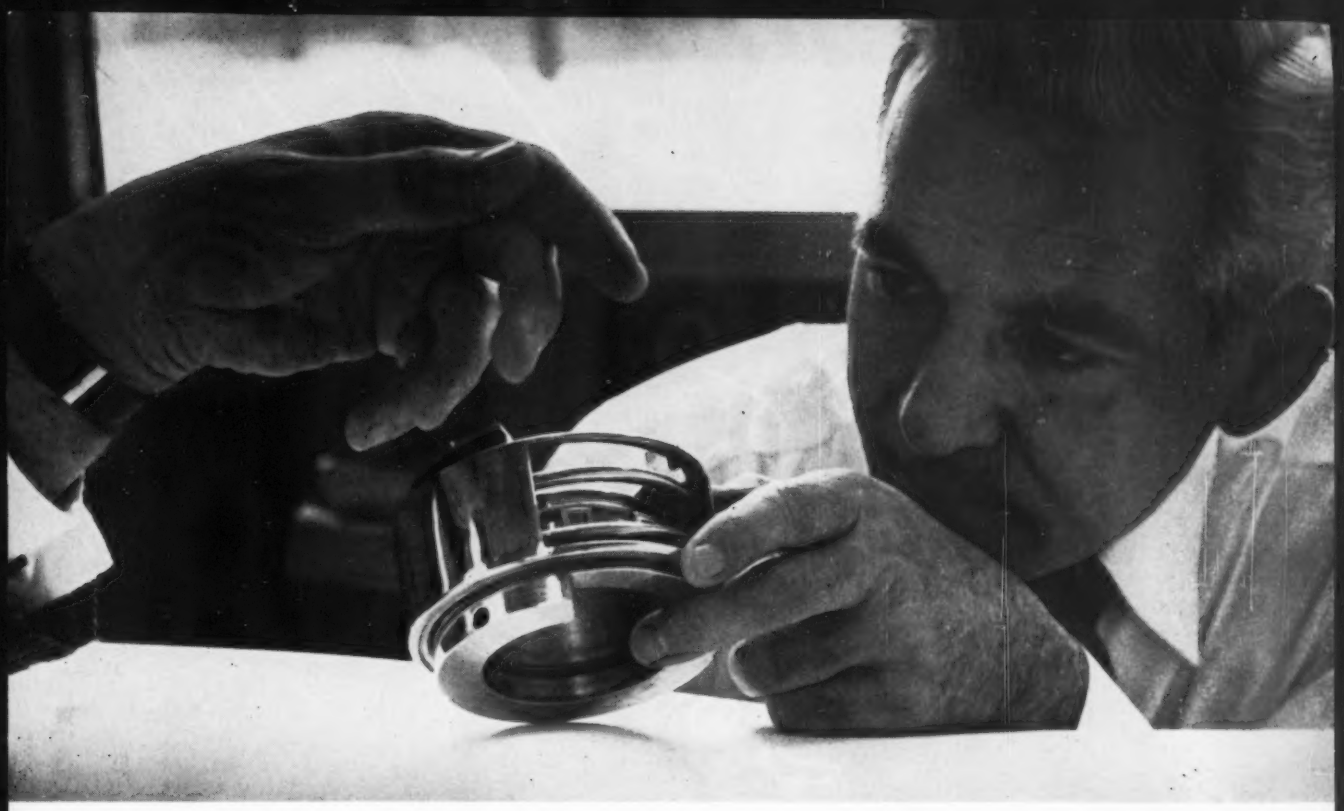
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Koa Oil	Iwakuni	F C C	5,500 bbls	.....	Engineering	Early 1960	UOP	UOP/JGC	.....
		Delayed Coker (Thermal Cracker Revamp)	4,500 bbls	.....	Planning	1960	UOP	.....	.....
		Vacuum Distl.	8,400 bbls	.....	Engineering	Early 1960	UOP	.....	.....
Kyowa Fermentation Industry Co., Ltd.	.....	*Acetaldehyde	45 tons	.....	Planning	.....	Knapsack-Griesheim	Uhde	Uhde
Maruzen Oil	Matsuyama	Udex	1,500 bbls	$2,200,000	Under Constr	.....	UOP	UOP; J G C	J G C
		Benzene	6,600 tons/yr	.....	.....	.....	UOP	.....	.....
		Toluene	4,000 tons/yr	.....	.....	.....	UOP	.....	.....
		Xylene	4,000 tons/yr	.....	.....	.....	UOP	.....	.....
		Oxidation	20 tons	$4,000,000	Engineering	.....	S D	S D	S D
		Benzoic Acid	900 tons/yr	.....	.....	April 1960	S D	.....	.....
		Phthalic Acid Anhydride	2,245 tons/yr	.....	.....	April 1960	S D	.....	.....
		Isophthalic Acid	5,600 tons/yr	.....	.....	April 1960	S D	.....	.....
		Terephthalic Acid	2,500 tons/yr	.....	.....	April 1960	S D	.....	.....
		*Crude Topping	25,000 bbls	$1,400,000	Under Constr	Mid 1959	.....	Chiyoda	Chiyoda
	Osaka	Secondary Butyl Alcohol	15 tons	.....	Complete	.....	.....	Chemical Projects Assoc	Chiyoda
Mitsui Petrochemical Industries	Iwakuni City	Terephthalic Acid	.....	.....	Under Constr	Sept. 1959	S D	S D	Mitsui Shipbuilding
		Paraxylene	.....	.....	Engineering	Sept. 1959	S D	S D	.....
		Cat Reformer	.....	.....	Licensed	.....	.....	.....	.....
		Paraxylene	.....	.....	.....	Summer 1959	.....	S D	.....
Mitsubishi Petrochemical	Yokkaichi	Styrene Monomer	55.4 tons	.....	Complete	.....	B P M	B P M; Chiyoda	B P M; Chiyoda
		Ethylene Oxide	15.4 tons	.....	Engineering	Oct. 1959	S D	S D; Chiyoda	Chiyoda
				$28,000,000					
		Ethylene Glycol	9.2 tons	.....	Engineering	Oct. 1959	S D	S D ;Chiyoda	Chiyoda
		*Ethylene	76.7 tons	.....	Under Constr	.....	S & W	S & W	JGC/Staff
		*Polyethylene	30.8 tons	.....	Under Constr	.....	BASF	JGC/Staff	.....
Nippon Petrochemicals	Kawasaski	Ethylene	25,000 tons/yr	$16,000,000	Engineering	Spring 1959	S&W	S&W; J G C	S&W; J G C
		Butadiene	5,000 tons/yr				Esso		
	Yokohama	*Lube Oil	700 bbls	$1,000,000	Complete	.....	Texaco	Chiyoda	Chiyoda
Showa Denko KK	Tokyo	Synthesis Gas	121 Short tons	.....	.....	.....	Texaco	Foster Wheeler	Foster Wheeler
Showa Yuka	Japan	Polyethylene	.....	.....	Under Constr	Mid 1959	Phillips	Staff Braun	.....
Toa Nenryo Kogyo	Shimizu	Exp. Powerformer; Hydrofiner; Kerosine Acid treating; Copper Sweetener; Offsite Facilities	43,500 bbls	$12,500,000	Under Constr	.....	.....	.....	.....
Ube Kosan	.....	*Ammonia	100 tons/da	.....	Engineering	Jan. 1960	.....	Chemico	Chemico
KOREA									
Korean Government	Chung-ju	Urea	285 tons	$33 500,000	Under Constr	.....	Inventa-Vulcan	Hydrocarbon, McGraw Vulcan	Hydrocarbon McGraw
	Naju	*Urea	95,000 tons/yr	.....	Engineering	1962	Inventa	Lurgi, et al	Lurgi, et al
TAIWAN (FORMOSA)									
Chinese Petroleum	Kaoshiung	Alkylation	900 bbls	$1,600,000	Engineering	.....	Texaco	Badger Mfg	Staff
		Sulfur Recovery	10 tons	$300,000	Complete	.....	.....	Pintsch Bamag	Staff
THAILAND									
Thai Defense Ministry	Bangkok	Refinery	5,000 bbls	$20,000,000	.....	.....	.....	Japanese Fuji	Japanese Fuji

Australasia

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
AUSTRALIA									
Bitumen & Oil Refineries	Sydney	Diesel Unifiner	2,500 bbls	.....	Under Constr	.....	.....	UOP	Staff
		Crude	12,000 bbls	.....	Proposed	.....	.....	Procon	Procon
BP Refinery	Kwinana	Cat Reformer	10,000 bbls	$9,200,000	Under Constr	1959	.....	UOP Kellogg	Kellogg
Imperial Chemical Industries of Australia & New Zealand	Australia	Polyethylene	5,000 tons/yr	$5,040,000	Under Constr	.....	.....	.....	.....
Shell Oil	Newport	Oil Blending	.....	.....	.....	.....	.....	.....	.....
Shell Refining (Australia)	Clyde	Platformer	6,700 bbls	.....	Under Constr	.....	UOP	.....	Procon
	Geelong	Hydrodesulfurizer	11,000 bbls	.....	Projected	3rd Qtr. 1959	.....	.....	.....
Standard Vacuum	Melbourne	Refinery Revamp	.....	.....	Under Constr	Mid 1959	.....	Fluor	Fluor
	Adelaide	Refinery	30,000 bbls	$30,000,000	Planning	.....	.....	.....	.....
Shell Chemical	Clyde	*Resins, Alkylates	.....	$22,000,000	Planning	.....	.....	.....	.....
		*Sulfuric Acid	.....	.....	Complete	.....	.....	.....	.....
PHILIPPINE ISLANDS									
Gulf Oil	Luzon	Refinery	20,000 bbls	$23,000,000	Planning	Late 1960	.....	.....	.....
Shell (Philippines)	Manila	Refinery	.....	.....	Negotiating	.....	.....	.....	.....
Standard-Vacuum	Bataan	Refinery	21,000 bbls	$33,500,000	Planning	.....	.....	.....	.....
Union Carbide	Melbourne	*Polyethylene	15,000,000 lbs/yr	.....	Planned	1961	.....	.....	.....

* First appearance in tabulation.

Atlantic—Atlantic Ref. Co.
Austin—The Austin Co.
Badger N.V.—Badger Camprino N.V., Netherlands
Badger Mfg.—Badger Mfg. Co.
B & R—Brown & Root, Inc.
BASF—Badische Anilin & Sod. Fab.
Bechtel—Bechtel Corp.
Blaw-Knox—Blaw-Knox Co.
Braun—C F Braun Co
Braziliera
Calif. Res.—California Research Corp.
Canadian
Canadian Bechtel
Catalytic—Catalytic Construction Co.
Chemical Projects Assoc.
Chemico—Chemical Construction Co.
CTIP—Compagnia Technica Industria Petroli
Davis Construction
Day & Zimmerman
Devon Palmer
Dortmund
Dresser—Dresser Engineering Corp.
Ehrhart—Ehrhart & Associates, Inc.
Esso—Esso Research and Engineering Co.
Ferguson—H. K. Ferguson Co.
Fijinagata Shipyard
Fisher
Fluor—Fluor Corp.
Food—Food Machinery & Chem. Corp.
Foster Wheeler—Foster Wheeler Corp.
GHH
Girdler—Girdler Construction Division, Chemetron Corp.
Hawaiian Dredging
Heurtey
Hudson—Hudson Engineering Corp.
Hughes
Hydrocarbon—Hydrocarbon Research, Inc.
HWP—Head Wrightson Process, Ltd.
Inst. Pet., Zagreb
Japanese Fuji
JGC—Japan Gasoline Co.
Kaighn
Kellogg—The M. W. Kellogg Co.
Kidde Constr.—Walter Kidde Constructors, Inc.
Kidde Engrs.—Walter Kidde Engineers Southwest, Inc.
Kobe Steel
Kocks Still
Koppers—Koppers Co., Inc.
Leonard—Leonard Construction Co.
Litwin—Litwin Engineering Co.
Lummus—The Lummus Co.
Lurgi—Lurgi G. m. b. H.
Macco—Macco Corp.
McAlpine-Winpey
McKee—Arthur G. McKee Co.
Mitsui Shipbuilding
Montreal, SA
Nofsinger—The C. W. Nofsinger Co.
Olsen—O. L. Olsen Co.
Parsons—The Ralph M. Parsons Co.
Pintsch Bawag
Poole
Power Gas—Power Gas Corp., Ltd.
Pritchard—J. F. Pritchard Co.
Process Contracting
Procon—Procon, Inc.
Quaker—Quaker Valley Constructors
R & E
S&W—Stone & Webster Engineering Corp., Chemical Division
S&W Ltd.—Stone & Webster Canada, Ltd.
SBA—Soc. Belge de L'Azote et des Produits Chimiques du Marly
SD—Scientific Design
SETAL
SFST—Societe Francais des Services Techniques
SNAM
Simmon Carver
Soc. Chemique—Societe Chimique de la Grande Pareisse Stamicarbon
Stearns-Roger—Stearns-Roger Mfg. Co.
STEC
Sumner Sollitt—Sumner Sollit Co.
Sweco—Southwestern Engineering Co.
Technoexport, Prague
Tellepsen—Tellepsen Petro-Chem Constructors
Treco—Refinery Engineering Co.
Uhde—Freidrich Uhde, G. m. b. H.
U.O.P.—Universal Oil Products
Vulcan—Vulcan Engineering Division
Ziegler



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Rumors Can Hurt!

A vicious word or half-truth from the company grapevine can cost your organization much money and ruin employe morale

B. R. Hooper
Convair, Division of General Dynamics
Fort Worth, Texas

AS LONG AS there are people, and they talk to one another, there will be a grapevine. From this grapevine will come a few peddlers of "inside dope." This grapevine will grow and bear the rancid fruit of rumor. Rumor that is uncontrolled and misunderstood can strangle management effectiveness, lower morale and cause production to nosedive.

The grapevine is an ever-present factor in modern industrial communication. What employes discuss among themselves may be none of the boss' business, but it should certainly be his concern if the word is not good.

In most companies the grapevine is built-in and can be expected to operate efficiently without regard for the truth of an item, or its consequences.

The grapevine seems to be a result of the tendency among people to gossip. Because of this tendency, and its possible effect on morale and production as such, it would be profitable to investigate some of the aspects of the grapevine and the control of rumor.

How Do Rumors Grow? Rumors seem to grow and thrive in the absence of facts. As a result, those employes who are uninformed, or feel they are (which for them is the same thing) are the ones most likely to supply their own facts and conclusions. Thus, the seed of another rumor is planted.

There is the persistent belief that there must be some truth in every rumor. "Where there's smoke, there's fire" and other such ideas add strength. It seems that if any part of a rumor is true or later comes into being it tends to add confidence in the grapevine.

How Rumors Spread. Experts tell us that a rumor tends to spread by clusters. One person tells three others.

Rumors thrive on the uninformed

Two simply receive the information, the other one passes it to another cluster of three or four and so it goes. In every group, some people are more rumor-prone than others, both in the reception and transmission.

Those rumor-prone employes are not necessarily anti-management. They are, however, job centered. That is, they are intensely interested in anything that might possibly affect their job, with those with whom they work, so they naturally want to talk about those things. Very often, they are informal leaders with a reputation for being "in the know."

A good manager should be aware of those with whom he works who are most sensitive to rumor and attempt to see that they keep their facts straight.

Case History. This story will illustrate. The rumor that went through the plant said, "employes with less than two years' service would be laid off next week." The fact was, that a small electronics contract was lost. However, the grapevine failed to pick up the rest—"No lay-off anticipated." By the time the supervisors returned to their sections the rumor machines were running faster than any others. In this case, as it so often happens, the "word" was steered around the supervisor, with the result that a number of hard-to-get, highly-trained technical employes quit before the

Don't let your employes get tangled in the company grapevine.

rumor could be straightened out. The morale of the remaining employes sagged.

Conversely, a good grapevine is often overlooked as an excellent source of information. If employes are so little interested in their work that they do not engage in "shop talk" such as the wisdom of company policies, who is in line for promotion, who is pregnant, who is hunting a job elsewhere—they are in an abnormal work atmosphere.

How Rumors Start. Rumors start in a number of ways. Generally, it goes something like this:

Bill, an eyewitness, sees some occurrence. If Bill is to tell what he saw,we are in trouble already, for Bill is not completely accurate in his observation. He uses words to communicate to Joe. Joe gets a distorted picture, as words mean different things to him than they did to Bill. Details are omitted and a few added, and certain ideas are highlighted. Joe tells Tom with further distortion, and a rumor is on its way.

Remember, it takes two to make a rumor. Yet what goes on in one person's mind is the crux of the matter and he may pass it on, not realizing that he is the vehicle of the tale.

Why Rumors Multiply. Office and shop rumors are always present. They thrive during periods of stress, labor unrest and change. Rumor will grow and fester under any condition in which the employee is drawn into closer association, due to a problem situation.

A rumor can fill a double purpose. On one hand it caters to the need of the individual to make sense in the world around him and, on the other hand, it provides an outlet for underlying emotional tensions. Any human situation can spark a rumor, but fear, hope, anxiety, insecurity and hostility supply the motives wherein rumor can fester and grow.

Often rumor meets simpler needs, providing us with what we want to hear, those things that make us feel good, or simply kill a conversational void. It may satisfy someone who wants to be the center of attention or add to his reputation of being a man in the know.

Why Rumors Stay Alive. Experts tell us that a rumor stays alive only when it has some importance for the teller and the listener. Rumors also attract more attention when the truth is clouded.

This uncertainty may be brought about by the absence, sketchiness or conflicting nature of the news or information. In the rumored story, it is often impossible to tell what the underlying facts are—or if any exist, and once the theme has been accepted, there is a tendency to distort subsequent news or events to conform to the central theme.

Another general rule in regard to rumor is that the farther the story spreads, the more likely it is to become twisted and garbled in the process.

What starts out as idle speculation in one department may wind up creating confusion and havoc in another department or an entire plant. Generally, fear is at the base of such items as, "They won't need any clerical help when they install the new computer." On the other hand, wishful thinking such as "I hear we're due for a big raise" can cause morale to plunge when it is realized that there was no truth to the story.

The following is an example that vividly illustrates the process and results of rumor:

"I wouldn't eat any fish for a while if I were you! I had a close friend who did and he almost died of what the doctors called radiation poisoning." How could such a story start?

Perhaps a man became sick. Then, there are the atomic tests in the Pacific. Japanese tuna fishermen, radiation and fallout have been in the news.

As a rumor such as this develops, it usually goes through three stages wherein the details are (1) simplified, (2) magnified and (3) wrapped up.

During the simplifying period the gossip or rumor takes the raw material and chops off, either through malice, ignorance or simply a desire to be noticed, anything that will decrease the neat little news package. In the previous case, the news releases to the contrary and the distance are not mentioned.

Next, the simplified, easily-told story is taken and certain details are sharpened or magnified. These become attention-getters. In this story a man's supposed illness becomes a matter of life and death due to radiation effects.

Then, the wrap-up gets its final form from one's imagination, emotional reaction and prejudice. And, presto, another rumor is on its way to do untold damage. This is complicated by the fact that every rumor seems to stem from an unimpeachable source.

Rumor Experiment. In order to demonstrate rumor development and vividly show the effect on production

and morale, the following experiment is usually effective.

During a lecture to supervisors five or six are asked to step into the hall to aid in the experiment. A large picture of some industrial scene is uncovered and explained to the class. In order to make the scene meaningful and realistic, it contained elements out of everyday work experience of the viewers. In this case, problems such as safety violations, overtime, absenteeism, idle time, horseplay, improper material handling and storing, radiation hazards, facilities' misuse, waste and equipment damage, smoking in restricted areas and carelessness (pictured by a fork lift operator watching a well-proportioned young lady, rather than where he is going).

One member of the voluntary team waiting outside is called in and asked to study the scene carefully for two minutes. He is encouraged to absorb and remember as many *details* as he can and repeat them as *accurately* as he can. Then, invite the next man into the room and have the first tell

Here's an experiment you can perform which will clearly demonstrate to your supervisory personnel how a story can become quite distorted as it is passed from person to person.

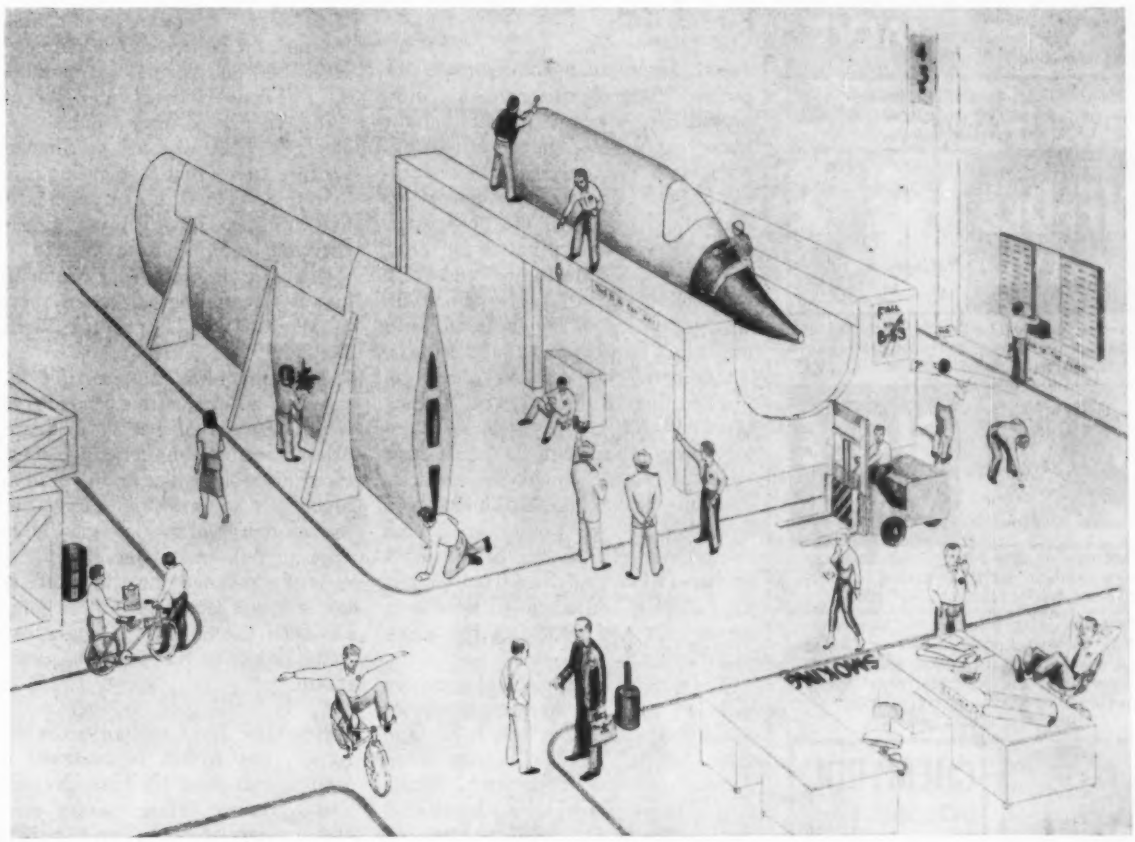
the story of what he saw, being careful that the man stands behind the picture so the audience can study the scene as the story is being told. Then ask a third man in, and have him listen while the second man describes what he heard. After that let each listener become a describer as he tells a new man what he heard.

Usually, the first volunteer will tell the story with a wealth of details and elaboration, attempting to make the story creditable. The second man, however, is unable to remember all the details he has been told and many of them do not meet his needs, so they begin to drop out. Then the story goes from man to man, through the simplify, magnify, and wrap-up cycle; twisting, changing, distorting as it goes.

A copy of that scene is provided below for you to use in conducting your own rumor experiment.

Kinds of Rumor. Rumors generally fall into three categories: hope, fear and hate. The first, hope, generally occurs when the public wants something to happen—such things as a raise, end of the recession or an election out-come.

Hope. Examples of hope rumors are seen in the premature release by the newspapers in the Dewey-Truman



As the details of this scene are told, the facts will become quite distorted.

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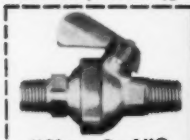

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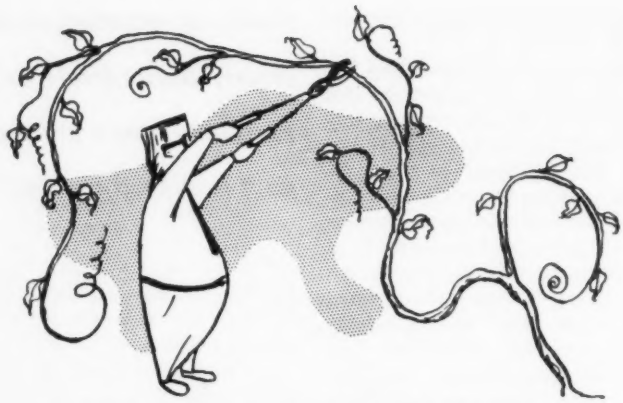


You can stop the growth of rumors by giving your employes the facts

election fiasco, reporting that Dewey had won.

The 1945 V.E. and V.J. Days saw premature announcements by both radio and newspapers concerning the end of the war. We encounter a powerful condition of public anticipation when, after a long wait, the end is in sight.

Although costly and possibly dangerous, hope rumors are not nearly so damaging as the next group, those based on fear!

Fear. In a small Texas town the authorities and citizens were in a near-panic. A rumor spread that the water supply had been poisoned. Some said they received their warning from neighbors, while others swore they either saw it in the newspapers or on television. And, after all, ". . . the water did taste funny" and ". . . what about all this unexplained illness going around?" The water was tested and no pollution found, but the rumor persisted for several weeks.

Then there is the story . . . "During World War II at an Air Force training base an aircraft crashed and burned between two wooden barracks, scorching one of the buildings. In a letter home to his mother, an airman related this as a matter of course. A few weeks later, a friend from the airman's home town wrote, expressing regret over the fact that the camp burned down.

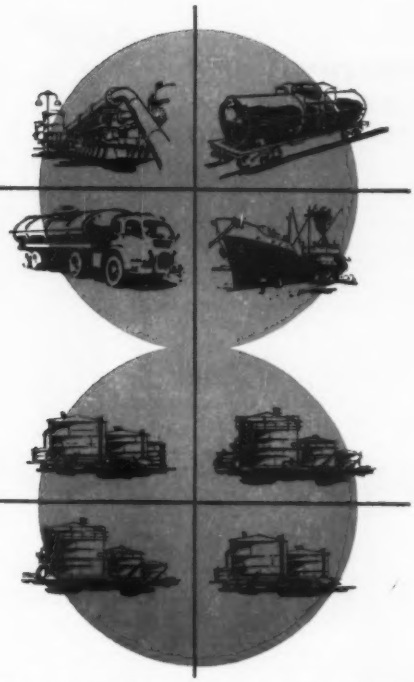
Then, there are those that are more vicious . . . "See that empty service station? Shame about how it came to close. Seems 'X' Oil Co. was doing some secret atomic research. Whatever they were working on broke and got into the tanks that were to be used for those cans you see in the stations. This service station manager kept changing customers' oil and, finally, the stuff began to eat him up. He is in the hospital now and, if he lives, he will probably be sterile." . . . (The other versions add the question "What effect will this atomic oil have on car engines and the health of the people who drive the contaminated cars?") The truth—the station closed because of a route change that cut the flow of customers.

Tales of rumor can go to fantastic lengths and do irreparable damage to individual and corporate reputations. As J. Edgar Hoover stated recently, "Any enemy of the United States clever in the ways of psychological warfare knows that by planting rumor in proper places he can spread fear, hate and suspicion, disrupting production and undermining morale."

A final example of fear rumor that had a devastating effect on morale in World War II and the Korean Conflict.[1]

A mother was supposed to have received a letter from her son who was a prisoner of war in a Japanese prison camp. In the letter the son assured his mother that he was well and urged her to save the stamp. Since the mother had not previously had any interest in saving stamps, she carefully steamed the stamp off and under it was lettered . . . "My tonque has been cut out!" The truth was—that prisoner of war letters carried no stamp.

Hate. The final category, the hate rumor, has within it countless examples that feed on bias, prejudice and ignorance. These rumors generally malign minority and religious groups, costing dearly in solidarity



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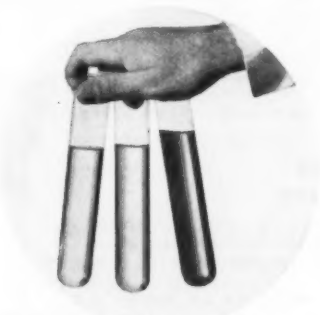

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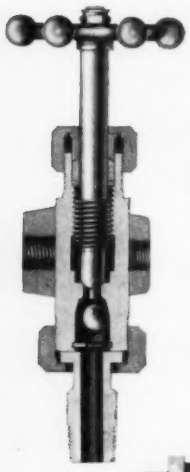

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and poor human relations, as well as measurable losses in business and industry.

Controlling Rumor. Can rumor be controlled? Experts say that with improved communication up and down the line, the number and intensity of rumors can be decreased.

Most rumors that fly in the face of fact can generally be traced to a breakdown in communication. So, the first step in stopping the growth and spread of rumor is *give them the facts.*

Next, not everyone in the organization is able to figure out the annual report or other company publications. The employes expect management to set them straight on matters of company policy, especially as it affects them. If answers are not forthcoming, the grapevine begins to buzz. So. *tell them why.*

Thirdly, *listen.* Listen to what your people have to say—find out what is on their minds. As Neil McElroy, then president of Proctor & Gamble said, "An employe does not have a sounding board or a public address system which permits him to tell you what he is thinking about or how he is reacting to what you are telling him."

By knowing how rumors develop, how they grow and thrive, they can more effectively be dealt with. And, perhaps, we can cut the staggering loss of manhours and morale which rumors cost companies each year.

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About the Author

Bill R. Hooper is industrial relations analyst for the Industrial Relations and Engineering departments at Convair, a division of General Dynamics Corp. An honor student in college, he was formerly on the administrative faculty of the University of Houston and received a B.S. degree in psychology there in 1951, and a M.A. degree in social psychology in 1955. He belongs to a number of organizations, including the National Management Club and the American Society of Training Directors.

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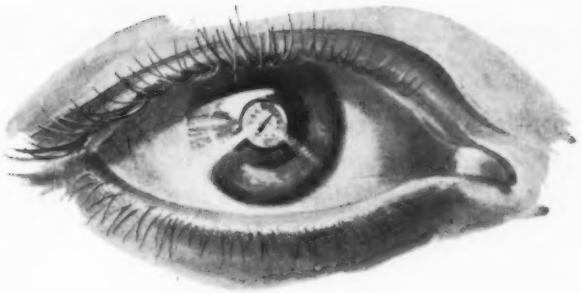

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Engineers—Get the Big Picture!

Ever wonder why more engineers are not considered for administrative positions. Sometimes it's a question of too much specialization—they can't see the forest for the trees

V. D. Schoeller
Remington Rand Division, Sperry Rand Corporation, Stamford, Conn.

ENGINEERS ARE basically specialists and all specialists in management attempt to achieve perfection in their decisions. This they do without regard to the needs or problems of other areas of management. In short, we tend to think unilaterally rather than universally.

However, rather than attempt to make "generalists" out of all engineers to the detriment of their specialized knowledge, we should attempt to become specialists-generalists. For in this role, we can understand the problems of over-all coordination of the total interests of the administration of company affairs.

Of course, this brings us to the point where we should define what we mean by administrative positions. There are actually many administrative positions within the specialized area of engineering which have little contact with the over-all, broad, and generalized problems of the total management picture of operating a business. Therefore, let us exclude from this discussion, those administrative engineering positions which may involve up to and include the title of "chief engineer" or "director of Engineering division."

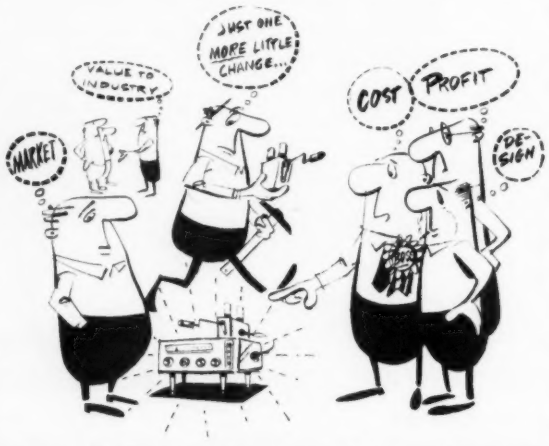
A "director of engineering research," for example, in a large and complex industrial organization may well encompass a wide range of administrative activities dealing with the administrative management functions of the pure engineering side of the business. Such an individual may or may not have contact with the marketing, production, financial and legal aspects of the overall business.

Let us, therefore, use the term "administrative positions" in the sense of those persons operating on the bridge of a large ocean liner rather than the pursers group or the stewards group. In this sense, it is very seldom that the chief engineer becomes the captain of that ocean liner. Let us therefore ask the question "Why?"

The Big Picture. Consider, for a moment, the words of Dr. Lillian Gilbreth, for many years a consultant on administrative problems for management and government. She has summed it up this way: "We are presently in the age of specialization. The problem is one of seeing the whole picture and the various interacting forces of management rather than of everyone attempting to have his own special problem solved first." Putting it another way, she stated, "We all tend to think unilaterally instead of universally."

The problem, therefore, is one of administrative control—a problem of seeing the entire forest instead of the trees—a problem of fitting the jig-saw pieces together and assembling them in their proper perspective so that we get a complete working machine instead of a series of forces pulling in opposite directions. It is a basic fundamental of human nature for each and every one of us to attempt to attain the perfect solution for our own particular part of the problem.

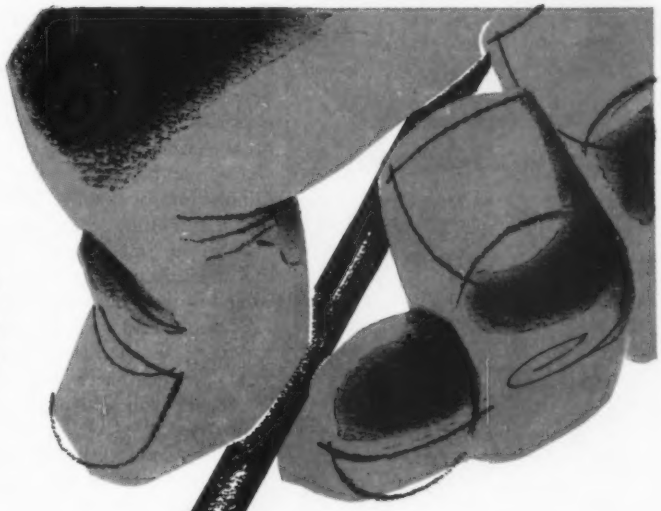
Actually, there is no such thing as a perfect solution because conditions change so rapidly that by the time we find the perfect solution to all part of the matrix of managerial problems, conditions have changed and we will have to start all over again. Here is a simple example:



As specialists, engineers tend to consider only the problems of their individual areas of responsibility

The Reluctant Engineer. In a client company of mine, immediately after World War II, a large volume market for television receivers was available. The engineering department had developed a new type receiver and a top management meeting was called to discuss the possibilities of placing it on the market. All areas of engineering, production, finance, legal,

IF YOU USE VALVES



YOU NEED THIS CATALOG!

Kerotest has been producing highest quality valves for the past 50 years for customers all over the world. Our new catalog—just off the press—gives dimensions, specifications and working tables to help you specify the right valves for refinery, industrial and marine applications.

Send for your copy—today!

KEROTEST

KEROTEST MANUFACTURING COMPANY

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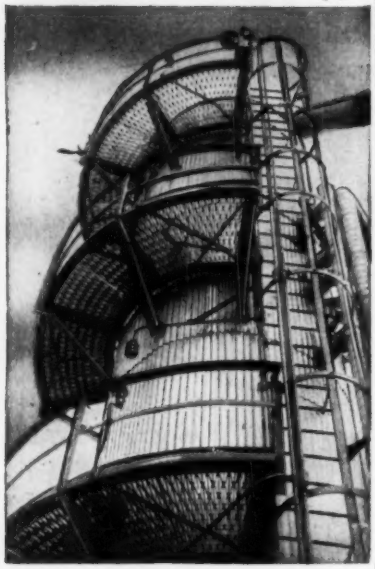
RAIN OR SNOW CAN MAKE CATWALKS DANGEROUS



Walkways, catwalks and treads made of solid wood, metal or other material can collect snow, rainfall, grease or oil and become dangerously slippery.

But these walking surfaces, made of an open mesh of metal bars on edge, cannot collect these substances, leaving the surface always clean, dry and tractional for safer access to high places.

As founders of the grating industry, the Irving Company can draw upon over half a century of experience to supply you with quality grating products for catwalks, treads and other practical and economical uses.

"A FITTING GRATING FOR EVERY PURPOSE"

Write for our General Grating Catalog.

IRVICO

IRVING SUBWAY GRATING CO., Inc.
Originators of the Grating Industry

Offices and Plants at
5090 27th St., LONG ISLAND CITY 1, N. Y.
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marketing and administration were represented at the meeting.

During the demonstration of the new machine, the engineering group expressed dissatisfaction with some of the working parts of the new chassis and mentioned numerous minor improvements which were possible if they could be given a little more time. During a break in the meeting, the president of the company took the vice president for sales aside and said to him, "You had better take this machine away from the engineers and freeze it. Otherwise, you will never get it on the market."

The obvious wish for perfectionism on the part of the engineering group would have delayed the introduction of this new TV receiver during a very crucial time. The administrative decision, therefore, was one that, while unpopular at the time with the engineers, proved to be the best one for the company as a whole. Perhaps the greatest difficulty, therefore, with any area of specialization, is the difficulty of arriving at an administrative decision which is best for the objectives of the company as a whole.

Consider All Areas. Remington-Rand has established two basic and prime standards against which to test all such administrative decisions. They are deliberately placed in succeeding order.

1. Is it in the enlightened best interest of the individual manager?

2. Will it produce a profit for Remington-Rand?

We can best mitigate repercussions of unilateral control decisions by at least considering the needs and problems of other areas of managerial responsibility.

There are at least seven areas of specialized managerial activity which, if allowed to operate unilaterally without considering the needs and problems of the other areas, can cause repercussions that may well wreck the entire business. These are markets, men, materials, machines, money, methods and managerial administration. If we construct these areas around a circle, we begin to see the concept of a wheel without a hub. However, each of us in our own area of specialization considers himself to be the hub and all other areas of managerial activity merely complement our own particular activity. Look at the dangers of any one of these areas being the dominant control factor or, as we have mentioned, the "hub" of the management wheel. Taking them one at a time, let us first look at Markets.

1. Markets. As the present dominance of the marketing function in the automobile industry shows us, the engineers are rapidly being driven out of their minds by the demands of the car stylists. Recall the statement attributed to Harlow Curtice of General Motors, "We don't give a damn if they have to crawl into them; if that's what they want, that's what they're going to get."

Actually, as we all know, our present automobiles are less safe than models of a decade ago. With the tremendous expanse of glass and the lack of support pillars, we may as well all buy soft top convertibles, from the safety point of view. When the first wrap-around windshield came out, (at the demand of the marketing department) one assembly plant found that it had to add 18 production stations to the assembly line, therefore adding substantially to labor costs and material costs of the automobile.

Furthermore, tall people of today should use knee guards as standard equipment to avoid the cracked kneecaps from the dog-leg corner windshield post when getting in and out of the newest contraptions they call automobiles.

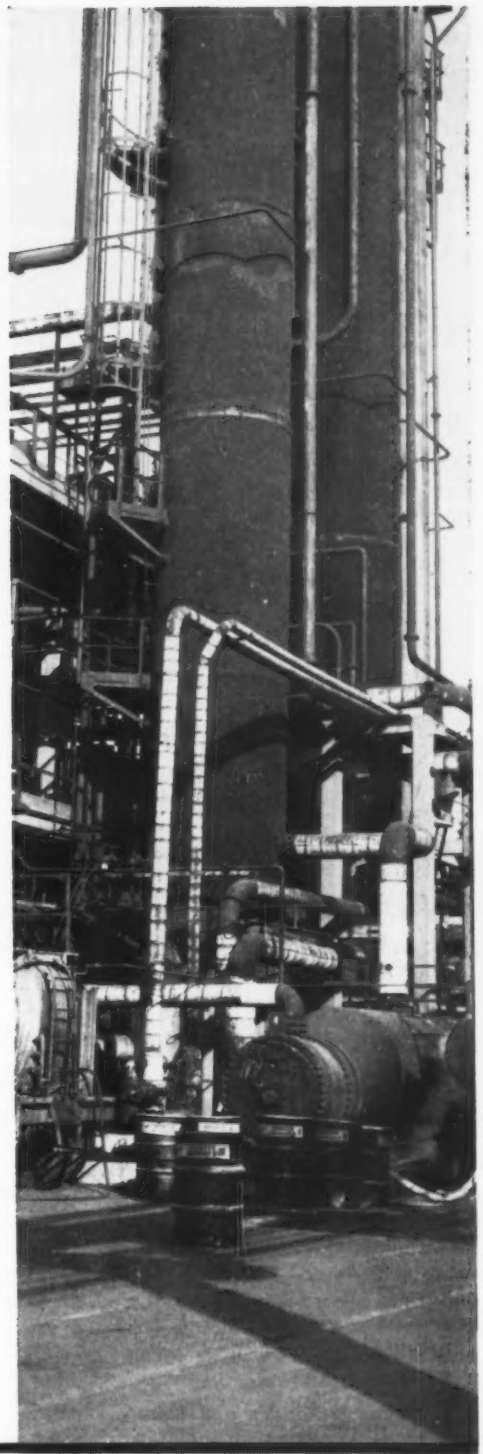
2. Manpower. Secondly, if the manpower, industrial relations, labor relations, public relations area becomes overly dominant, we will drive further and further into the colossal labor cost give-away program that has created the present wage push inflation situation in American industry. Statistics show us that from 1947-1957, hourly wages went up 72 percent, whereas productivity per man hour increased only 41 percent. This gives us a wage vs. output ratio for 1957 of a minus 31 percent.

The latest available statistics give our 1957 productivity output increase as 1.3 percent whereas Russia's 1957 productivity output increase was 4.8 percent or almost 300 percent greater than ours. This is a serious challenge to our entire econ-

For more data on advertised products, use Readers' Service Cards, last page.

Oakite ECP
engineered cleaning program

saves 3 days downtime with 1 drum of cleaner



Severe vibrations threatened to tear up a 30,000 cfm air blower before it reached even half-speed. Diagnosis: an oil leak from the previous run had probably carbonized on hidden areas of the impeller. A cat cracker, just getting back on-stream, was threatened with another three days downtime if the blower had to be taken apart.

Remedy: call the Oakite man. (An Oakite ECP includes *technical service.*)

The Oakite man proposed pumping a mixture of Oakite 8, water and steam into the blower—to clean it in-place. A few hours later refinery was able to put 160,000 lbs. of air per hour into their converter (the highest rate ever). This meant they were able to crack higher and increase gasoline, propane and butane yields. Downtime was eliminated; three day production loss (33,000 bbls.) avoided. ALL WITH ONE DRUM OF MATERIAL!!

WHAT IS OAKITE *ECP? ECP stands for Engineered Cleaning Program. It's a program of periodic chemical cleaning tailored for your refinery. It considers your equipment, conditions and through-put—itemizes your problems and the materials and methods to solve them.

But an ECP is much more than a standard program. It's the eagerness of the Oakite man to make *your* emergencies *his* concern. It's his experience in refinery cleaning, backed by the finest cleaning research facilities in the world, supported by materials *guaranteed* to work. Send for details. Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

OAKITE
50 1909-1959 SCIENCE
years' leadership in industrial cleaning

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

Oakite ECP
your economy key

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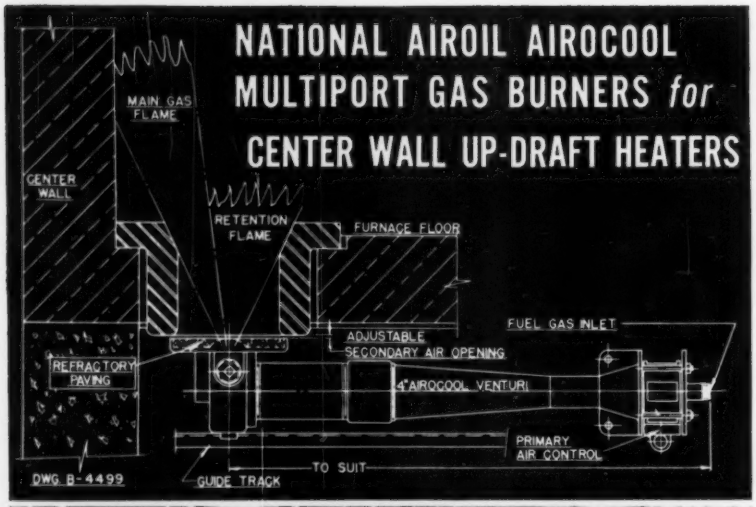

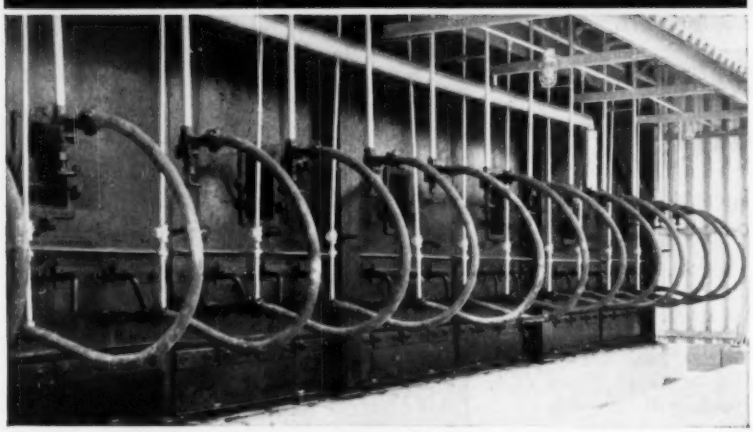

. . . were especially designed and developed for angled firing vertically in all types of radiating wall furnaces-heaters . . . They are not an improvization.

AIROCOOL MULTIPORT INCLINED GAS BURNERS HAVE:

- **Nozzles that can be machined to direct the flame impact at 15°, or any other desired angle to produce the highest degree of heat transfer by radiation from the incandescent reflecting wall. They produce a short flame.**
- **An accurate secondary air adjustment to allow close limits of any excess air and thus result in the highest fuel efficiency.**
- **Higher B.T.U. capacity and greater turn down ratio, with only scant furnace draft and with a minimum of secondary air.**
- **Unique design features that enables them to burn high Hydrogen gas without "flash back".**
- **A reduced size and weight of refractory burner block of inexpensive design.**
- **Means for easily and quickly withdrawing or inserting the gas burner, and requiring only a minimum of labor to accomplish it.**
- **A low maintenance factor including that of the nozzle which is heat protected on its upper surface.**

National Airoil
BURNER COMPANY, INC.
Main Office & Factory: **1254 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.**
SOUTHWESTERN DIVISION: 2512 SOUTH BOULEVARD, HOUSTON 6, TEXAS

omy. This becomes an especially ludicrous situation when senior pilots on jet aircraft ask $45,000 per year for flying 85 hours per month and railroad engineers between Philadelphia and New York City receive 2 days' pay for a 3 hour round trip.

3. Machines. In our third managerial area of machines and mechanical activity, we find equally odd situations. A good example of this is the case of the over-zealous engineers who designed a continuous automatic glass blowing machine for electric light closures. This machine had such a high capacity that an entire year's production could be turned out in six months.

The after-the-fact consideration by the marketing division disclosed that the total market could not be expanded sufficiently to keep the tremendous machine busy. In a desperate effort, the machine was modified to turn out Christmas tree ornaments but even with both markets satisfied, the machine capacity was still a great deal more than the total market per year for both areas of products.

4. Materials. Our fourth area, Materials, is equally dangerous when those specialists in charge of purchasing and inventory control make unilateral decisions without considering production or engineering problems. A good example of this is the purchasing agent who made a substantial dollar savings for his company by saving a few cents a pound on raw material through accepting slightly inferior specifications. Let us call this situation an "ash tray" which requires a deep draw in a punch press.

When manufacturing costs began to skyrocket, an investigation showed that the inferior material ruptured in the draw operation and therefore the workers stopped the press for each piece to oil the material in order to prevent rupturing. This additional operation added far more to the total production cost than the purchasing agent saved by his unilateral decision in buying the sub-standard material.

5. Money. In our fifth area, Money, probably the most favorite whipping boy of all other areas of specialization is the financial group which

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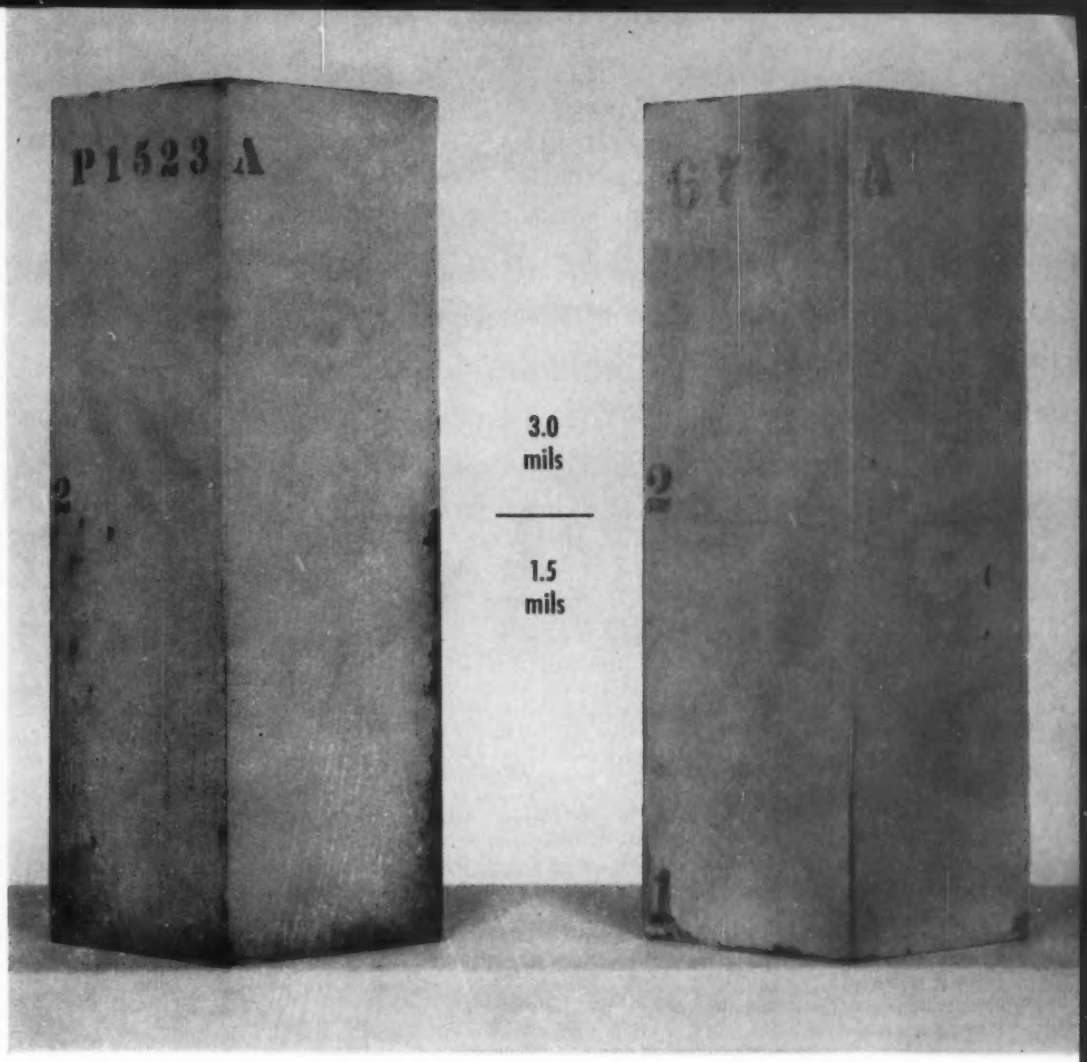


Never before such durable protection, never before such lasting appearance in metal protective paints.

Proof anti-corrosion finish paints made with M50® pigment give unique freedom from bilging

Compare . . . for color . . . the gray alkyd finishes on the two exposure test angles shown above.

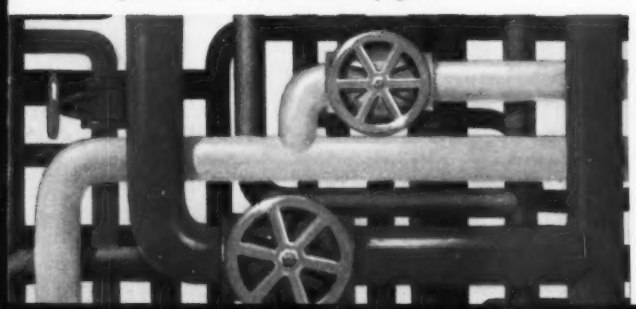
By all previous concepts for anti-corrosion paints, the one on the left should be the darker, should show some splotchiness . . . even though the paint on both angles came out of the same can. That's because the angle on the left was exposed (four years, 45° S) to the heavily sulfur-laden industrial atmosphere of Perth Amboy, N. J., while the angle on the right was exposed (four years, 45° S) only to the normal atmosphere found at National Lead's Sayville, L. I. Test Station.

As you can see, the color difference . . . bilging . . . that you might expect from SO_2-caused precipitation simply has not developed in this paint made with *M50* pigment.

Combined with its unique resistance to discoloration by the chemicals found in industrial atmospheres, fused M50 basic lead silico chromate pigment demonstrates exceptional rust inhibitive action.

Now, with *M50* pigment, your regular paint suppliers can provide standard or heavy-coat anti-corrosion primers, intermediates and finishes with superior rust inhibition, superior weather resistance, and excellent tintability. Paints that are more durable and don't bilge. The *M50* pigment is suitable for use with a wide variety of vehicles.

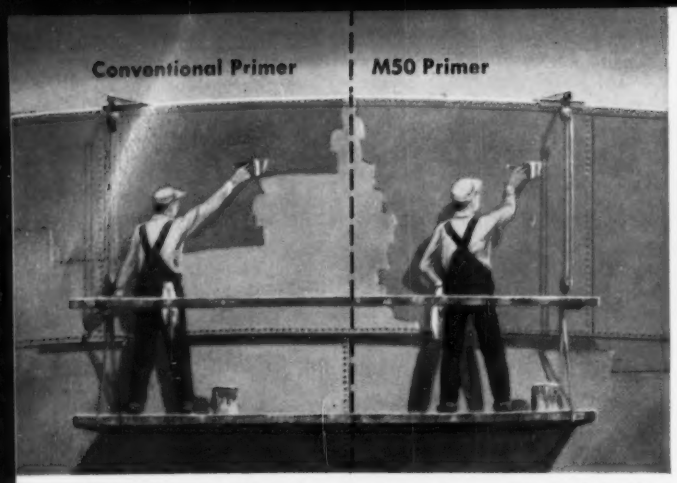
Color code paints look better longer, are more protective, too, with M50 pigment.



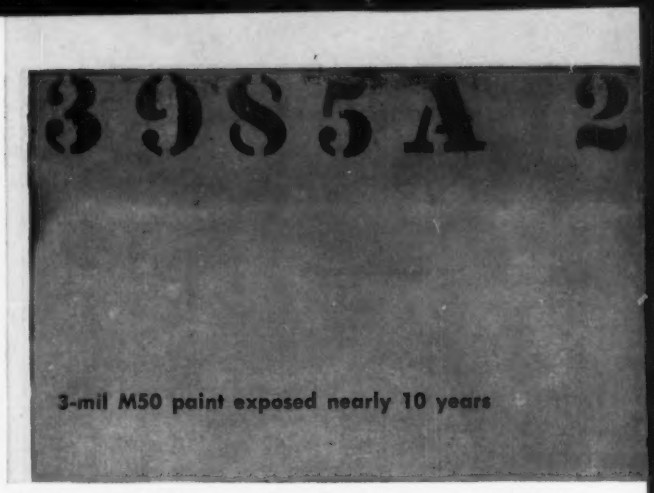
See, on the next page, more details . . . and how you can get these new, much more durable anti-corrosion paints.

M50 pigment is a product of National Lead Company

General Offices: 111 Broadway, New York 6, N. Y.



Weight for weight, anti-corrosion paints made with high-bulking M50 pigment cover 40% to 60% more steel.



Mil for mil, M50 paint films show better rust-inhibitive performance, lengthen the painting cycle interval.

Here's evidence M50 pigment paints reduce anti-corrosion maintenance painting costs two ways

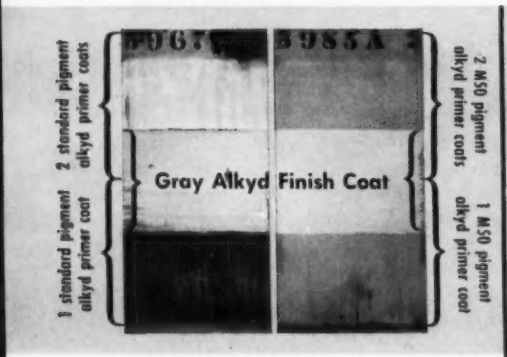
On the preceding page you have seen evidence that *M50* pigment paints are unique among anti-corrosion paints for anti-bilging properties. Exposure tests at National Lead's Sayville, L. I. Test Station have demonstrated these metal-protective paints are also unique for their anti-corrosion action, their weather-resistance, their color stability and many other performance characteristics.

Above you see evidence that *M50* pigment paints are equally unique in their ability to provide anti-corrosion maintenance painting economy. The illustration at left gives you a visual comparison between the coverage of a conventional anti-corrosion primer and an equal weight of an *M50* counterpart of this same primer (Fed. Spec. TT-P-86a, Type I). Clearly a given weight of *M50* pigment paint goes further.

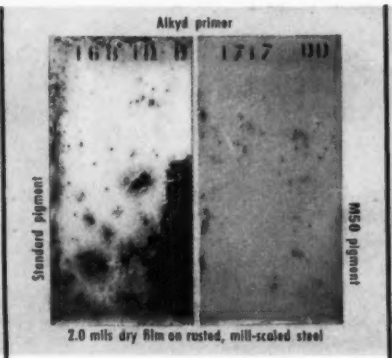
The picture at the right shows the condition of a 3-mil *M50* pigment *primer* exposed nearly 10 years *without a finish coat.* You can see that even in this severe test . . . an unprotected primer . . . anti-corrosion action is still being obtained. The repainting surface is still in good shape. Weather has not adversely affected protection. Imagine how many years of service you can anticipate from anti-corrosion *M50* finish coats applied over anti-corrosion *M50* primers in the normal or heavy coat systems!

Based on cost per sq ft per year, M50 pigment paints can greatly reduce the cost of your anti-corrosion maintenance painting.

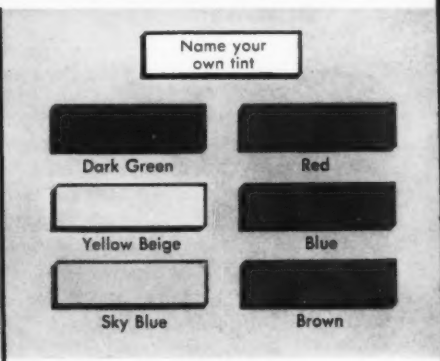
Why M50 Defense in Depth paints give anti-corrosion beyond all former concepts


2 standard pigment alkyd primer coats
1 standard pigment alkyd primer coat
Gray Alkyd Finish Coat
2 M50 pigment alkyd primer coats
1 M50 pigment alkyd primer coat

Exposed 9 years, 45°S. Each coat 1.5 mils
Proved corrosion and weather resistance



Exposed 45°S, 1 yr ind. atmos, 1 yr normal atmos.
Proved outstanding for film strength, durability



Colors above available in conventional and heavy-coat paints
A wide range of stable colors can be produced

Are you concerned with tank or structure maintenance painting in your firm? If so, you are invited: (1) to visit National Lead's Sayville, L.I. test station, where you will see the results of the 20 years research that lies behind the *M50* pigment particle and the more than 10 years of exposure testing that lies behind *M50* pigment Defense in Depth paints; (2) to send coupon below for National Lead booklet, "Defense in Depth" and typical *M50* tank paint specifications.

Next time you purchase, specify *M50* pigment paints. Any paint manufacturer can supply you.

M50 Defense in Depth

National Lead Company,
111 Broadway, New York 6, N. Y.

Gentlemen: Please send me the "Defense in Depth" booklet together with typical tank paint formulas and color chips that I can use in specifying M50-type tank paints.

Name_____ Title_____

Firm or Dept._____

Address_____

City_____ State_____

seems to have only one answer to all questions and that is "no, No, NO." Very often the accounting and financial group can justify many illogical policies by their specialized methods of manipulating the books. Probably one of the most frustrating situations an engineer can find himself in is requesting new or modified equipment and being told by the financial group that the existing equipment has not been fully depreciated and therefore the new purchase can not be approved.

Yet, the financial specialists often feel that they are the administrative control of the entire company. Take the following depreciation problem for example. Some years ago I found myself taking time studies of an operator working on a lathe. During the course of the activity, I noticed the operator leaning on the machine and therefore dutifully noted on the time study form, "Operator idle—leaning on machine." Several days later I received a call from the foreman of that department who informed me that my time study was inaccurate. I told him that during my observation the operator had truly been idle—he was leaning on the machine.

The supervisor said, "Yes, you are right. He was leaning on the machine but I have news for you. He was leaning on the machine because he had to. The bearings on the machine were so sloppy that he was leaning on the shaft in order to hold the proper tolerance."

Upon investigation I found from the accounting group that they were justifying the continued operation of these machines on the basis that they had been fully depreciated a number of years previously and therefore were being carried at scrap value on the books. Therefore, in their specialized point of view, any production that they got out of these machines was pure gravy because, according to their books, no machine charges were entered against that production.

This is entirely fallacious thinking. The loss of material due to scrap and the extra cost of hiring a high-grade machinist to operate old machines versus a potential hiring of new and lower paid employes to operate semi-automatic machines then available on the market, was actually causing a higher production

ELLIOTT air magnetic tube expander drives

automatically controlled for fast, accurate tube rolling

Designed for faster, precision tube rolling, the standard model Elliott Air-Magnetic drive is setting new records for speed and accuracy. Some operators average 12 tubes per minute. Desired torque easily preset by rotating forward end of unit. No tools needed. Rolling stops when preset torque levels are reached. Includes trigger-controlled, explosion-proof air motor in single unit. Magnetic control, no springs. Balanced for easy handling. For tubes ¼ in. through 3 in. *Standard model* handles most jobs. *Heavy-duty* for higher torque.

ALSO Electric Control ... Tube Expanders ... and Related Accessories

Elliott offers the Automatic Electric Control—an accurate torque-limiting device designed for tube expanding with any standard tapping motor. Also, a complete line of tube expanders, with rotating, parallel, self-feeding rolls. Available in 4 sizes, ranging from ¼ in. to 3½ in. O.D.

Other related accessories include Elliott tube gage, tube plugs, tube pilot, and tube rolling lubricant.

Write for descriptive literature *today*.

Y9-3

ELLIOTT Company
LAGONDA PLANT, Springfield, Ohio

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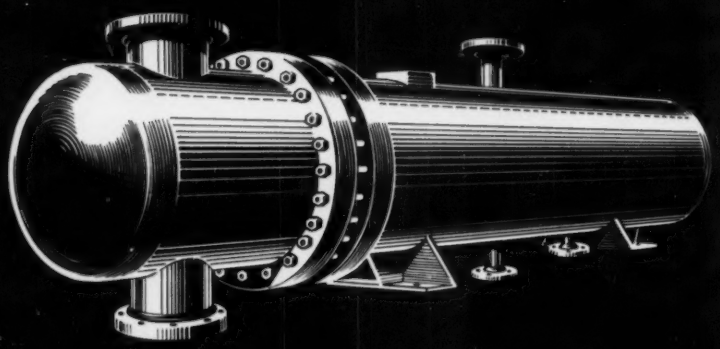
MANNING & LEWIS



M & L CARBON STEEL REACTIVATION CHILLER
made to A.S.M.E. code. (Dimensions 18" outside diameter shell, 7' overall length, weight 2000 pounds).

Today's rapid strides in the technology of processing plant operation make it essential for a manufacturer of equipment to be "staffed up" with people who have had extensive training and experience. More than half our staff have spent a major part of their working life in this one field and have played a major role in the design and fabrication of many types of processing equipment. They know the limitations and workability of all metals and how to get maximum service from each. This accumulated knowledge of base materials and our extensive experience in design and fabrication means practical, trouble-free equipment at the lowest possible cost.

It is impossible, in a field requiring such wide diversification, to illustrate, or even list, all the products we have been called upon to supply. The chiller above is simply one among thousands.

Call on us the next time you need equipment. We are fully qualified to design and fabricate to all codes.

M&L MANNING & LEWIS
ENGINEERING COMPANY
Dept. C, 28-42 Ogden Street, Newark, New Jersey

DESIGNERS & MANUFACTURERS OF QUALITY HEAT EXCHANGE EQUIPMENT

cost than if the accounting department had approved the purchase of new machines.

6. Methods. In our sixth area, that of Methods, we find too often the zealous enthusiasm of the methods engineering group completely ignoring the needs of the other areas of management. Some years ago I conducted a methods study of the production line on a bottled liniment. This is a very strong liniment and was bottled in a hand-blown bottle resembling a monk, wearing a cassock. The equipment was old and held together with "baling wire and tape." The bottle was very expensive and the methods were atrocious. A complete redesign of the machinery, methods and a much cheaper bottle would save many thousands of dollars per year.

We forced the proposal through and were patting ourselves on the back for a most successful project, when the marketing department suddenly woke up to the fact that liniment sales had dropped to almost nothing.

Investigation showed that this liniment was sold mostly in the hillbilly areas of the U.S. where illiteracy is common. For many years, these backwoods people had been pointing to the monk shaped bottle on the shelves and saying, "I want that." It seems they could not read the printing on the new box and, therefore, they did not see their familiar bottle on the shelves, so they merely asked the general storekeeper for liniment. Inasmuch as the general storekeeper received a higher mark-up on competitive liniments, the sales went almost completely to the competition.

After some very hurried managerial discussions it was decided to go back to the old bottle and, as a result, the sales of this liniment went back up to the original level and the entire Methods department had a very red face.

7. Management. Our seventh area, that of Managerial Administration, again has serious repercussions from unilateral decisions. One cannot stress too strongly the one-man rule of Henry Ford and the famous quote, "They can have any color they want as long as they take black." The Ford Motor Co. has since recovered from this unilateral aspect of managerial control. How-

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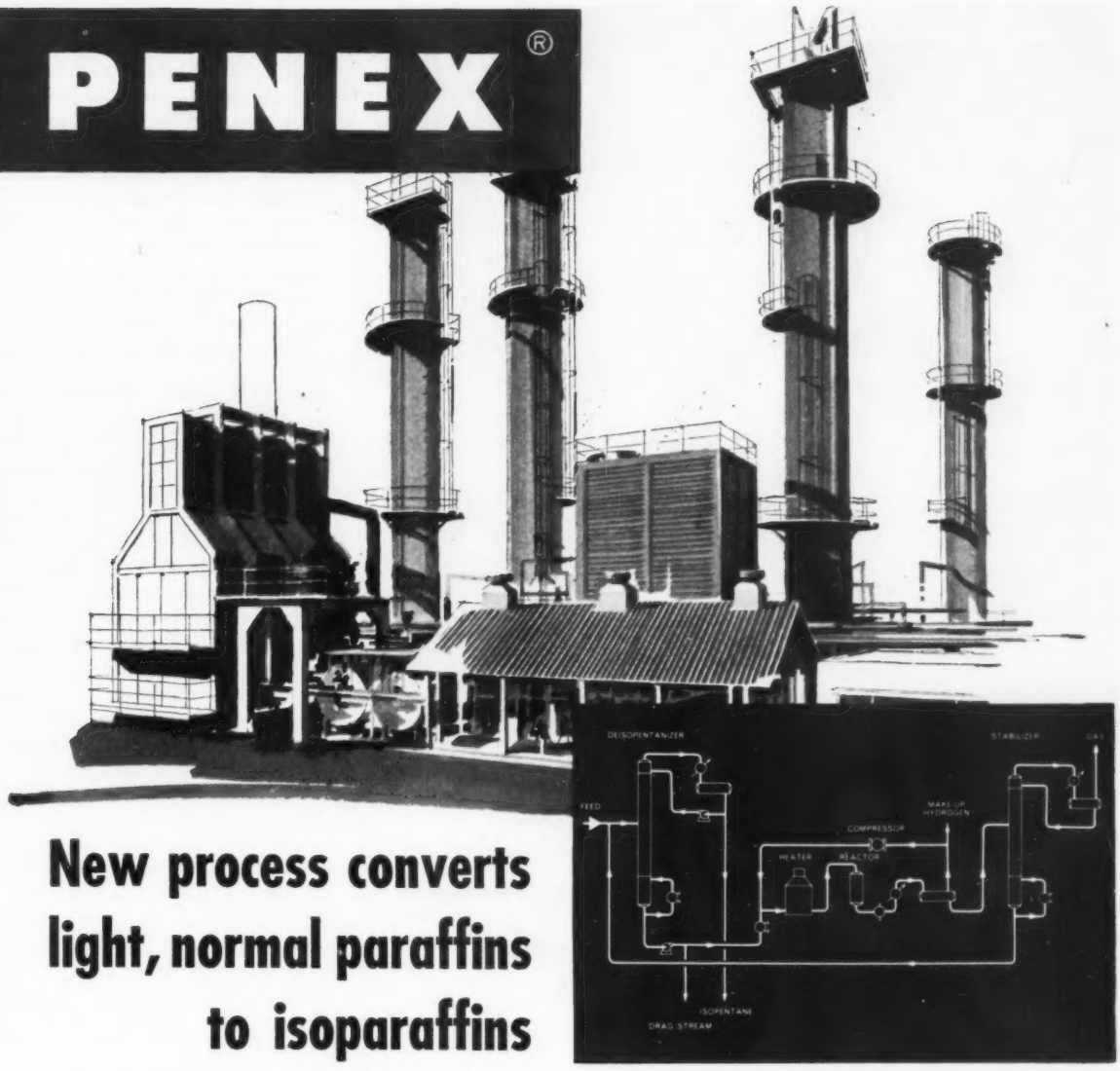
PENEX®



New process converts light, normal paraffins to isoparaffins

Here is a process which for the first time enables the refiner to economically upgrade pentane and hexane fractions, thus producing a high octane product with improved burning qualities, without plug-fouling and pre-ignition, with better sensitivity and better lead susceptibility.

The Penex process is economical in installation, operation and maintenance. Regeneration is not required, thus reducing capital investment, simplifying operation and reducing maintenance. Catalyst and reaction products are non-corrosive so lower cost carbon steel construction can be used.

Penex has an additional advantage when used with a reforming process such as Platforming®. Make-up hydrogen used in Penex processing is derived from the Platforming net high pressure separator gas. Hydrogen is consumed in insignificant quantities. This combination of processes also gives a considerable yield advantage at the same octane number.

Many other UOP processes are available to the refiner who is seeking ways to improve his operating efficiency and manufacture the kind of products that will bring him maximum market and economic benefits. These processes are available to all refiners. They are described in an informative fully illustrated booklet, "UOP Processes and Products," which will be furnished on request. Write for your copy today. Address:

UNIVERSAL OIL PRODUCTS COMPANY

30 Algonquin Road, Des Plaines, Illinois, U. S. A.

More Than Forty Years Of Leadership In Petroleum Refining Technology

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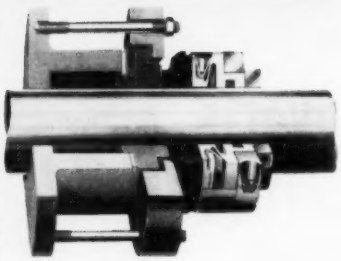
LAST LONGER IN CORROSIVE CHEMICALS



Garlock Chemiseal® Mechanical Seals possess greater immunity to corrosion and are more economical than any other design offered. This reputation is based on fact—customers report unsurpassed performance on applications like these:

- **Pumping HYDROXYACETIC AND SULFURIC ACID**
  1750 rpm, 1½" shaft. 10 lbs. suction, 60 lbs. discharge. Temperature of medium 30° C. RESULT: Chemiseal greatly extended service life.
- **HIGHLY ABRASIVE SERVICE (ESTER—10% SOLIDS SLURRY)**
  3600 rpm. 625 lbs. discharge, 30 lbs. suction. Stuffing box pressures 15 lbs. to 65 lbs. Temperature of medium 70° C. RESULT: Chemiseal gave longer, leak-proof operation.
- **Pumping CONCENTRATED SULFURIC ACID**
  1750 rpm. 1 1/16" shaft. 2 lbs. suction. 45 lbs. discharge. Temperature of medium 65° C. RESULT: Chemiseal gave longer life.
- **Pumping ADIPIC ACID AND HYDROCARBON SLURRY**
  1750 rpm. 1⅛" shaft. 35 lbs. suction, 75 lbs. discharge. Temperature of medium 70° C. RESULT: Chemiseal lasted longer, cut downtime.

Join the list of satisfied users. You can apply standard Garlock Chemiseal Mechanical Seals to all pump shafts from ⅞" to 2⅛". Special sizes also available. They seal against all mediums—including solids in suspension—in pressures to 100 psi at 75° C, or 75 psi at 100° C. Chemiseal Mechanical Seals are another of the Garlock 2,000 . . . two thousand different types of gaskets, packings, and seals for every need. Find out complete details by contacting your local Garlock representative, or write for Catalog AD-164.

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ever, one wonders at such situations as the present large office machine manufacturer where an over-aged management injected no new blood over a long period of time and exercised unilateral control over its activities to the point where the corporation faced bankruptcy.

On the other hand, too much administration can cause just as serious a set of problems as in the example of the Pentagon mess where the creation of administrative committees got completely out of hand.

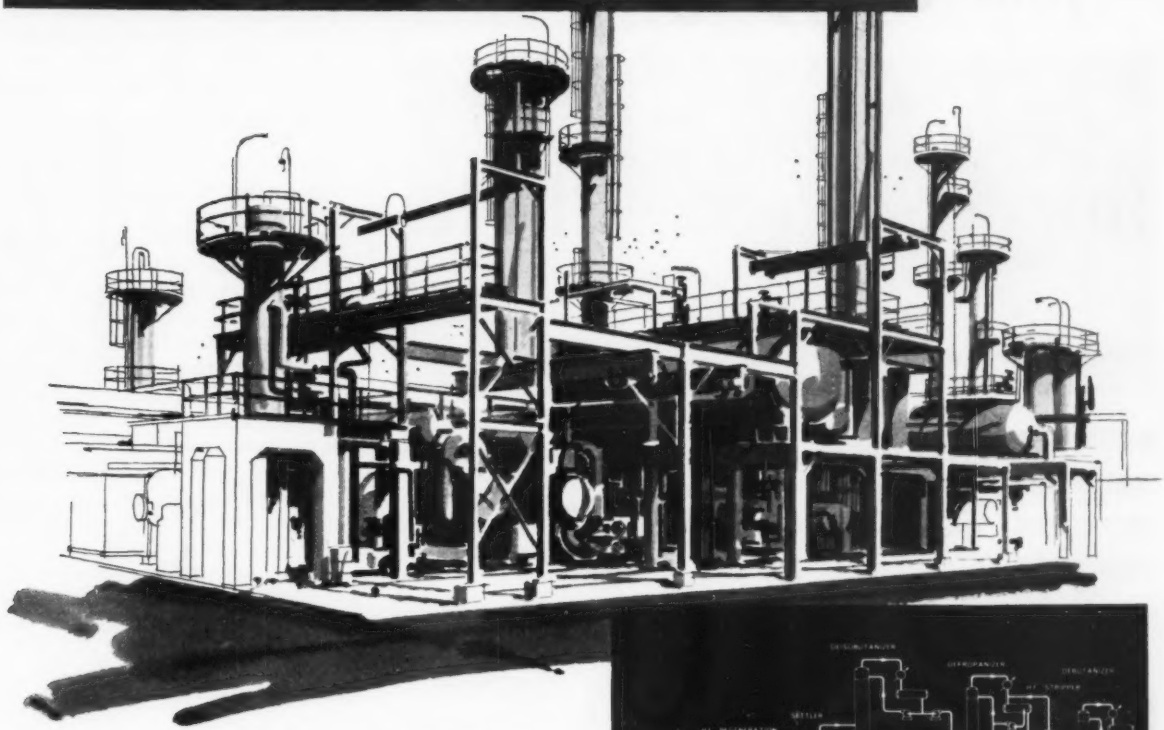
Here is the Hub. No matter where we look at the picture, whether it be at engineers or at all specialists in management, we must begin to get the big picture and not just the potential dominance of our own specialized area. Each time we look at the wheel of management and picture our own specialty as the hub we become more narrow-minded in our particular outlook. We cannot become true administrators or aspire to positions in administrative management until we realize that overall administrative control is the hub and not any particular specialty.

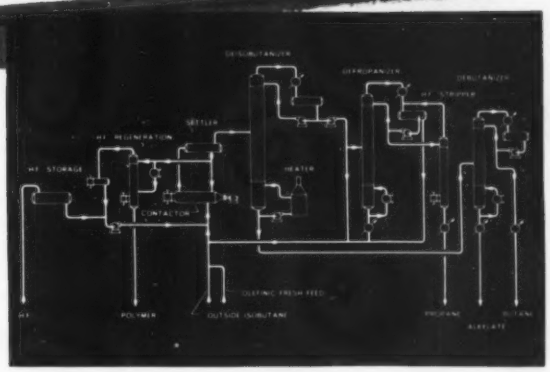
This is not to take the conclusion that we must all become generalists, because it is impossible to make generalists out of everyone. In addition, we would lose the advantages of specialization. It has been said that engineers are generally more perfectionist-minded and specialist-minded than other areas of managerial activity. I do not believe this is true. I believe that every specialist cannot help but feel his specialty is most important. Otherwise he would belie his basic training and experience.

No, I do not believe we can create overall generalists. Rather, I believe we should envision a different term—that of "specialist-generalist." We should be specialists first and generalists second. The combination is one in which management and engineers must create a climate of cross-fertilization and task-force considerations to enable each engineering specialist to at least see and understand the other person's problem.

Final Analysis. Going back again for a moment to Dr. Lillian Gilbreth, one of her most quoted statements is that, "We must first define and understand the problem and

HF Alkylation





Makes Alkylate, Top Anti-Rumble Motor Fuel

A practical, economical means of producing motor alkylate, a high octane, top quality gasoline blending component, is available to petroleum refiners through the UOP "HF" Alkylation process.

"HF" Alkylation is a catalytic process which combines olefins such as propylene, butylenes and amylenes with isoparaffin (usually isobutane) to form a mixture of branched chain hydrocarbons of higher molecular weight known as alkylate. "HF" Alkylation is also widely used for producing high octane aviation gasoline.

Motor alkylate, an isoparaffin fuel component, burns with a minimum of carbon deposits even in today's modern high compression automobile engines and thus greatly reduces surface ignition and its consequent "rumble."

Another method for producing alkylate is also available to refiners through UOP. It is similar to the "HF" method but uses sulfuric acid as the catalyst. This process is licensed by Universal Oil Products Company under their own patent rights and the patent rights of Shell Oil Company, The Texas Company, The British Petroleum Company, Limited and Standard Oil Company of New Jersey.

These processes for producing alkylate afford further evidence of UOP's policy of providing the refining industry with every means for a well-rounded, profitable manufacturing operation.

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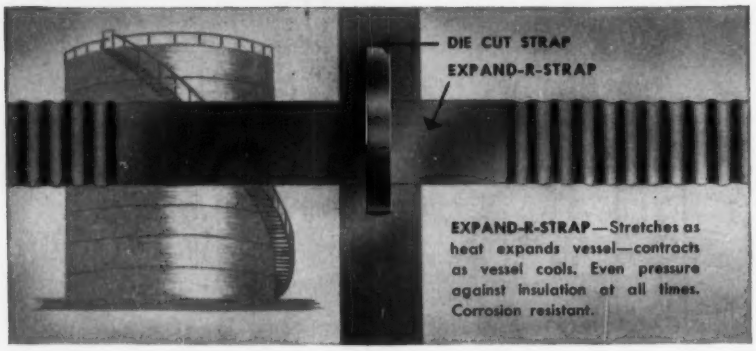
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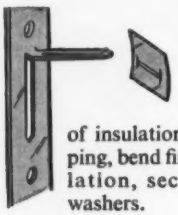

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then the solutions become self-apparent."

When we realize that all of the other specialists in management also have their own specialized problems, we can at least create an understanding between each other which will lead to better administrative management control. After all, in the final analysis, the main problem of all management activity is to create the desire in the mind of the consumer to buy our products or services and to return a total profit to the company.

If we create a perfect product that cannot be sold at a competitive price or an inferior product that cannot stand up competitively, we have somewhere lost the ability to adjust and compromise in creating a blended, unified picture out of the jigsaw cutouts represented by each of our specialized managerial areas. I am sure that once we accept the specialist-generalist viewpoint, more engineers will then be considered for administrative positions.

Originally presented before the annual meeting of the American Society of Mechanical Engineers, New York City, December 2, 1958.

About the Author

Dr. V. Donald Schoeller is director of management development, Sperry Rand Corp.'s Remington Rand division, Stamford, Conn., where he handles all executive appraisals, inventory, and forward planning and training of company managers. He has 18 years' industrial experience and holds a B.S. degree from Seton Hall University, M.B.A. degree from New York University, and Ph.D. degree from the University of Pennsylvania. He has been an industrial engineer for American Home Products Corp., Western Electric Co. and Bendix Aviation Corp. Schoeller has also been a professor and consultant at Case Institute of Technology and Wharton School, University of Pennsylvania.

A Condenser Tube for Every Job

PRIME SURFACE TUBE

Wolverine keeps in step with processors' demands—not only with Wolverine Trufin® Type S/T, but with additional types of condenser tubing. From this complete line you can specify exactly the tube you need to meet your particular demands. Into each of these products goes all the research, the engineering skill and Tubemanship, that has made Wolverine a leader for more than 40 years. Your tubing dollars develop real stretchability!

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DUPLEX PRIME SURFACE TUBE

Duplex TYPE S/T

This tube also is designed for specific corrosive conditions. But, like Trufin, it has integral fins—will boost heat transfer efficiency. It can be used instead of prime surface tube.

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A high-finned, lightweight aluminum tube is mechanically bonded to an interior liner of the alloy which best beats your corrosion hazard. It provides maximum heat transfer and trouble-free performance at low cost.

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This Wolverine idea cuts time, reduces storage problems, and saves money. U-bend condenser tubes—either finned or prime surface—are arranged in a disposable box-type pallet in the exact order you specify. All you have to do is feed them directly from pallet to unit.

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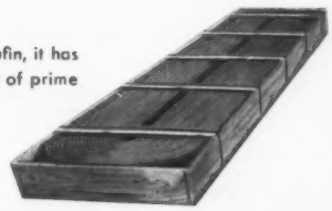
U-BEND PALLETS



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Are You Paying Too Much Overtime?

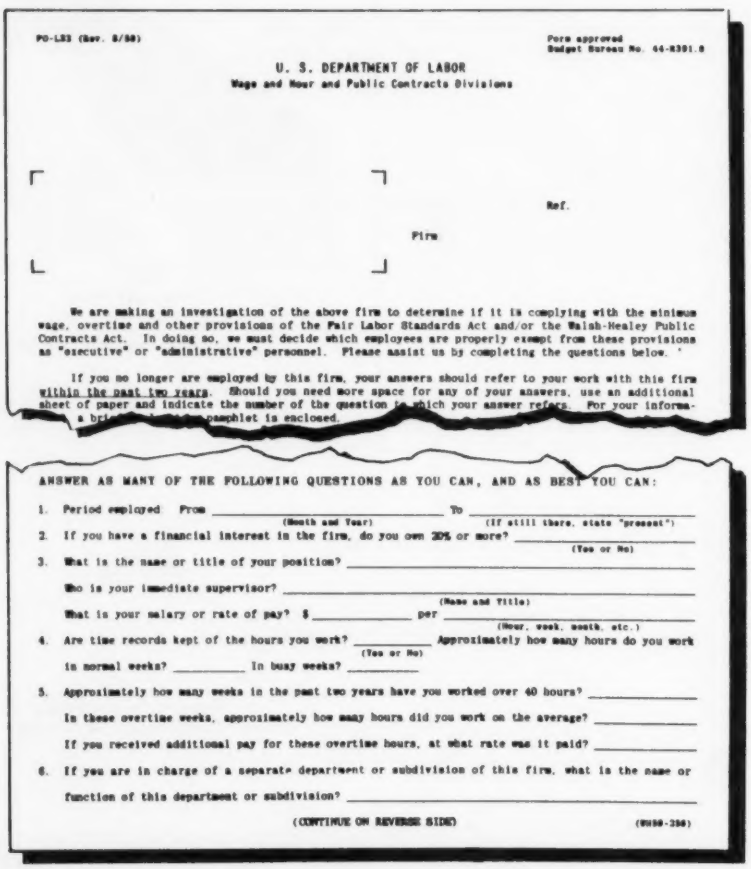
Here are some valuable pointers on the wage law, plus some help on how you should compute and control overtime costs

Robley D. Stevens
Management Consultant, Washington, D. C.

LOOK AROUND your refinery. Can you, right now, account for your overtime costs? One discovery you can make is that overpayments as well as underpayments in the compensation of personnel could be a real source of grievances—and even unnecessary governmental investigation.

And yet, your refinery may be paying a larger overtime bill than necessary because you possibly may be using an incorrect method of computing your overtime cost. In substance, the Fair Labor Standards Act states that anyone covered by the law must be paid overtime for work beyond 40 hours a week.

Employes in your refinery who receive a higher rate than the statutory minimum of $1.00 per hour should be paid at a higher rate on the basis of time and one-half that rate. You should know and understand that the term "regular rate" is defined as to include all remuneration for employment paid to your refinery employes, except payments of seven types specifically described later.



PO-L83 (Rev. 8/58) Form approved Budget Bureau No. 44-R391.8

U. S. DEPARTMENT OF LABOR
Wage and Hour and Public Contracts Divisions

Ref.

Firm

We are making an investigation of the above firm to determine if it is complying with the minimum wage, overtime and other provisions of the Fair Labor Standards Act and/or the Walsh-Healey Public Contracts Act. In doing so, we must decide which employees are properly exempt from these provisions as "executive" or "administrative" personnel. Please assist us by completing the questions below.

If you no longer are employed by this firm, your answers should refer to your work with this firm within the past two years. Should you need more space for any of your answers, use an additional sheet of paper and indicate the number of the question to which your answer refers. For your informa- a bri pamphlet is enclosed.

ANSWER AS MANY OF THE FOLLOWING QUESTIONS AS YOU CAN, AND AS BEST YOU CAN:

1. Period employed: From _____ (Month and Year) To _____ (If still there, state "present")
2. If you have a financial interest in the firm, do you own 20% or more? _____ (Yes or No)
3. What is the name or title of your position? _____
   Who is your immediate supervisor? _____ (Name and Title)
   What is your salary or rate of pay? $_____ per _____ (Hour, week, month, etc.)
4. Are time records kept of the hours you work? _____ (Yes or No) Approximately how many hours do you work in normal weeks? _____ In busy weeks? _____
5. Approximately how many weeks in the past two years have you worked over 40 hours? _____
   In these overtime weeks, approximately how many hours did you work on the average? _____
   If you received additional pay for these overtime hours, at what rate was it paid? _____
6. If you are in charge of a separate department or subdivision of this firm, what is the name or function of this department or subdivision? _____

(CONTINUE ON REVERSE SIDE) (WH50-236)

FIGURE 1—As the employer, you may or may not see this form. It is used by an inspector when interviewing an employe whose exemption status from the Fair Labor Standards Act is being questioned.

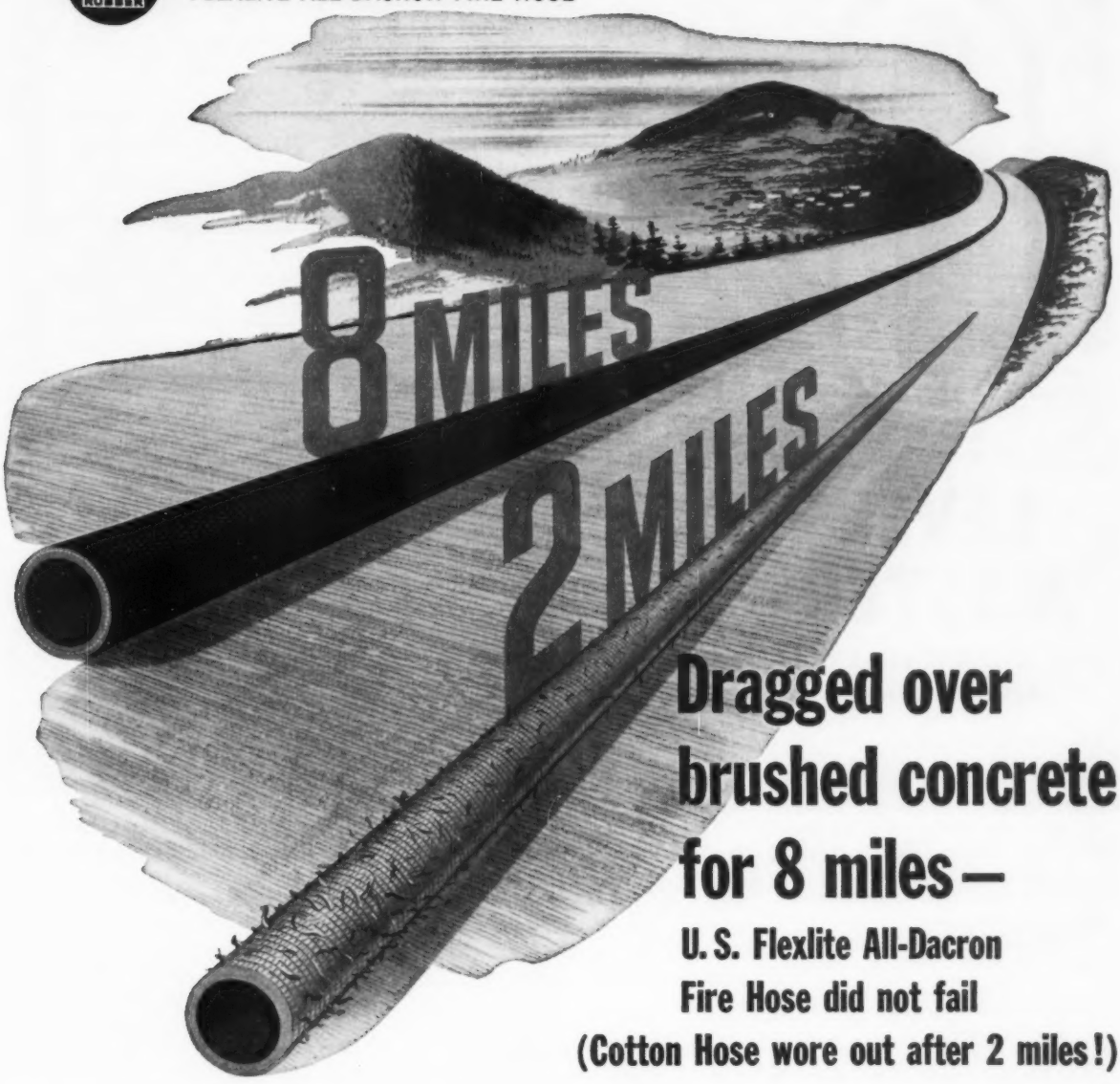
Minimum Goes Up. Your employes may work any number of hours weekly so long as they are paid overtime beyond 40 hours weekly, unless, of course, they qualify for the exemption status as an executive employe. To be exempt from the Act's minimum wage and overtime provisions, an executive employe must receive at least $80 a week instead of the $55 now required. Administrative and professional employes in a refinery, to be so exempt, must be paid at least $95 a week instead of $75 as at present.

Of course, your refinery under the wage-hour regulations is not required to pay these salaries. The new salary tests are for exemption purposes only. If an employe does not meet the new salary tests, as well as the duties and responsibilities tests which became effective February 2, 1959, he does not qualify for the exemption. In such a case, your refinery may of course continue to pay him on the basis of a salary, but the Act's minimum wage and overtime pay requirements must be met, unless some other statutory exemption is applicable.

Your refinery should also keep in

US RUBBER

FLEXLITE ALL-DACRON FIRE HOSE



Dragged over brushed concrete for 8 miles—

U. S. Flexlite All-Dacron Fire Hose did not fail

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U.S. Flexlite Hose brings you these other advantages: It won't absorb water and hence can't freeze. It is highly resistant to oils and chemicals. Every foot is subjected to five hundred pounds test pressure before leaving the factory.

This hose comes in any color for ready identification as a fire hose. This prevents its being carried off or utilized for purposes other than fire fighting.

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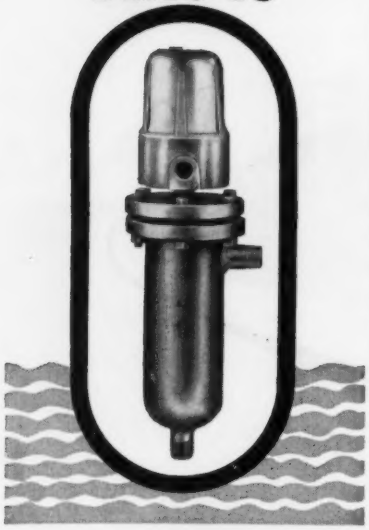

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- ***Models for all types of liquids.***
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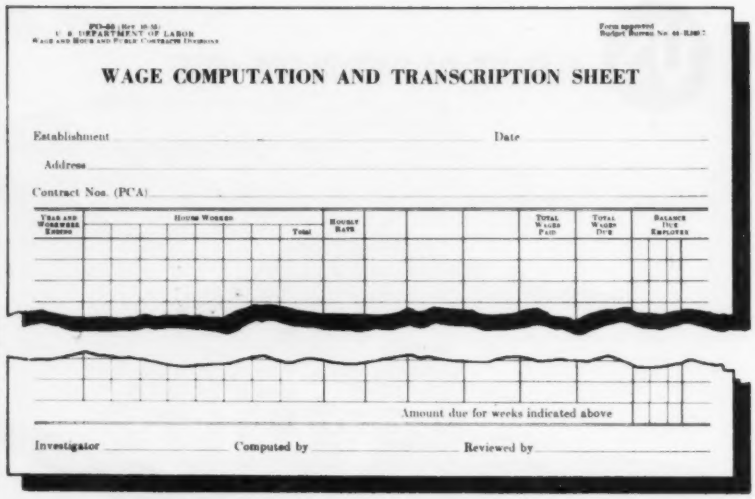
5456 W. 111th St., Oak Lawn, Ill.
Send full information on Level Master and name of nearest representative.

My name_____

Company_____

Address_____

City_____ Zone____ State____



WAGE COMPUTATION AND TRANSCRIPTION SHEET

Establishment_____ Date_____

Address_____

Contract Nos. (PCA)_____

Amount due for weeks indicated above

Investigator_____ Computed by_____ Reviewed by_____

FIGURE 2—This Wage Computation and Transcription Sheet is required if your plant is directed to make extension, recomputations or the like in computing payroll accounting information.

mind that these requirements apply only to employes who are engaged in interstate commerce or in the production of goods for interstate commerce, including any closely related process or occupation directly essential to such production.

A workweek is considered to be a regularly recurring period of 168 hours, seven consecutive 24-hour periods. It need not conform to the calendar week and may begin on any day.

The best thing to do, of course, is to have your refinery accountant audit your payroll books. Or, perhaps, you may want to use the following quick check-list of common overtime pay methods which I applied as a former wage-hour inspector.

1. Hourly Rate Employe. If an employe in your refinery works solely on the basis of a single hourly rate, the hourly rate is his regular rate. For his overtime work he should be paid a sum which is simply determined by multiplying one-half the hourly rate by the number of hours worked beyond 40 in the workweek.

For example, a $1.40 hourly rate should bring, for a refinery employe who works say 46 hours, a total weekly wage of $68.60 (46 hours at $1.40 plus 6 hours at 70 cents).

2. Salary Employe-General. If an employe in your refinery is employed solely on a weekly salary basis, his regular hourly rate of pay is simply computed by dividing the salary by the number of hours his salary is intended to cover.

For example, if he is hired at a salary of $56 for a regular workweek of 35 hours, his regular pay is $56 divided by 35 hours, or $1.60 per hour. When he works overtime, he should be entitled to receive $1.60 for each of the first 35 hours and $2.40 (one and one-half times $1.60) for each hour thereafter.

Where the salary covers a period longer than a workweek, such as a month, it should be reduced to its workweek equivalent. A monthly salary is subject to translation to its equivalent weekly wage simply by multiplying by 12 (number of months) and then dividing by 52 (number of weeks). A semi-monthly salary must also be translated to its equivalent weekly pay by multiplying by 24 and dividing by 52. Once the weekly wage rate is determined, the hourly rate should be calculated as indicated.

3. Salaried Employe-Irregular. Let's take the case of an employe who earns, say $66 per week with the understanding that his salary is to cover all hours worked. If his hours of work fluctuate from week to week, obviously, his regular rate of pay will also vary.

Suppose, for example, that during the course of four weeks he works say 40, 44, 50, and 47 hours. His regular hourly rate of pay in

ARE YOU GETTING YOUR SHARE OF THE HIGH OCTANE MARKET?

The consumption of Alkylate is growing for both government and civilian use, and this demand is expected to continue, at least into the middle 1960s. To get your share of the high octane market, consider adding an Alkylation Unit to your facilities as soon as possible.

The Oil and Gas Journal says, "Of the five typical high-quality blends which go into premium gasoline, alkylate is by far the best performer . . . more and more refiners are being pushed to include alkylate in their motor fuels. Heavy competition . . . is responsible for the new emphasis on alkylation."

WHY ALKYLATE IS THE KEY TO CURRENT GASOLINE BLENDS . . .

	Research octane (RON)	Motor octane (MON)	Sensitivity (RON minus MON)	Road octane (Union town)
Alkylate	103.0	104.5	−1.5	107.5
Reformate extract	103.7	94.0	9.7	103.5
C_5 plus reformate	103.0	93.5	9.5	102.5
C_5 plus reformate	100.0	91.7	8.3	100.0
Catalytic cracked	99.0	87.5	11.5	98.0

Reprinted courtesy The Oil and Gas Journal (Aug. 4, 1958)

OVER 50% OF ALL POST-WAR HF ALKYLATION UNITS OPERATING IN NORTH AMERICA WERE DESIGNED, ENGINEERED AND BUILT BY TRECO*

The Refinery Engineering Company has designed, engineered and constructed more HF alkylation units than all other companies combined.

THE TRECO LIST INCLUDES:

Shell Oil Company of Canada	1500 BPSD
NCRA	1522 BPSD
Cosden Petroleum Company	2068 BPSD
DX-Sunray (Tulsa)	2470 BPSD
DX-Sunray (Duncan)	3500 BPSD
CRA	1106 BPSD
Anderson-Prichard Oil Corp.	2150 BPSD
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The Carter Oil Company	2300 BPSD

Treco, with an outstanding record of fast refinery completion, can have your alkylation unit on stream QUICK. A telegram, telephone call or letter will bring complete information.

*to September 30, 1958

....talk with the TRECO man.....

TRECO

A DIVISION of VITRO CORPORATION of AMERICA

The REFINERY ENGINEERING Company

FARMINGTON NEW YORK TULSA TORONTO

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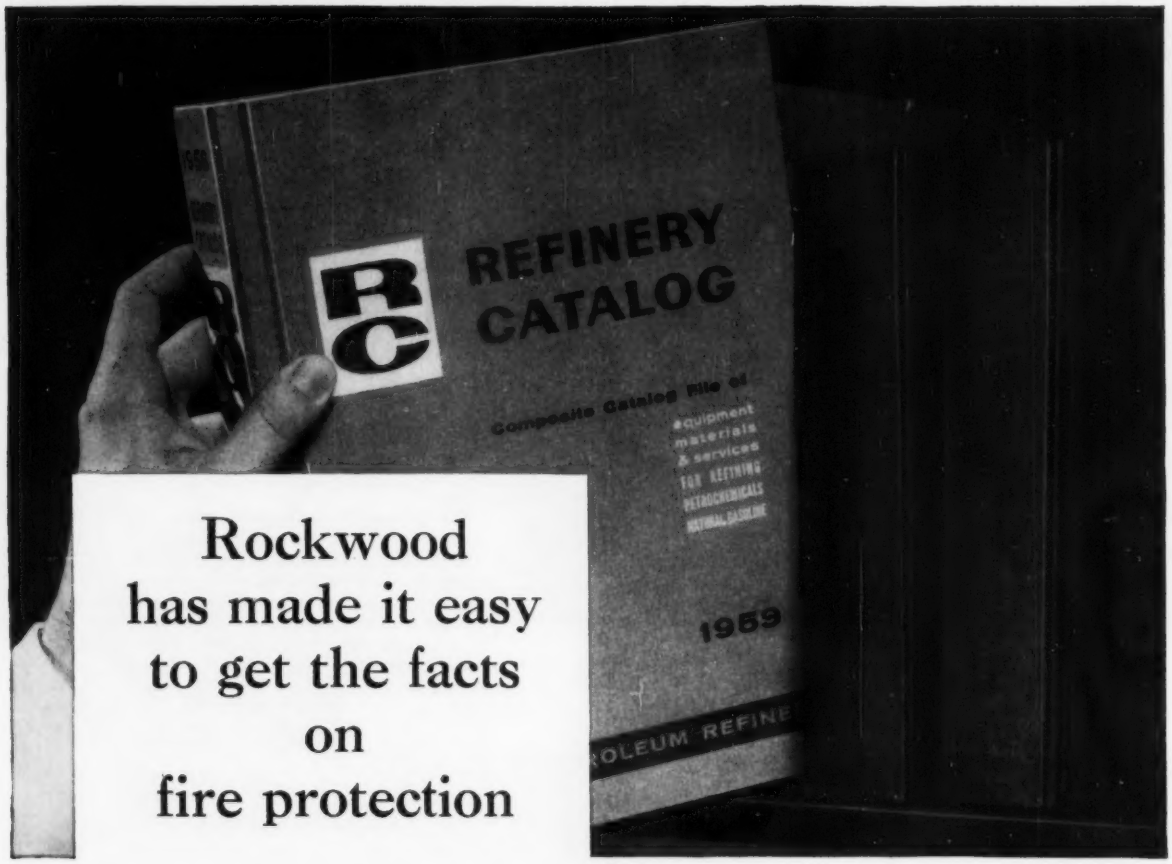
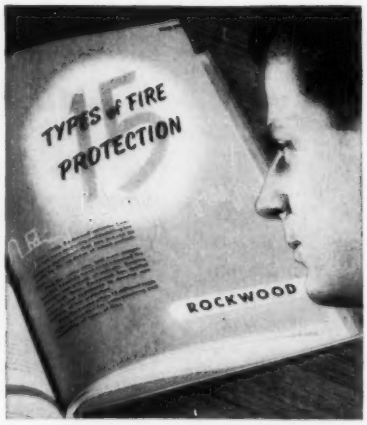


Rockwood has made it easy to get the facts on fire protection

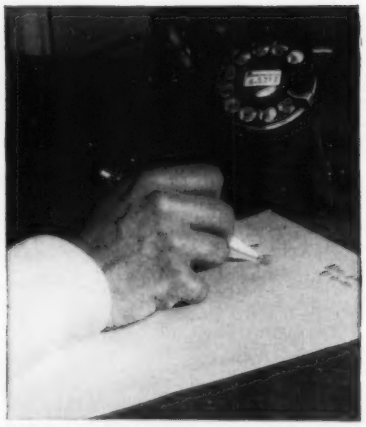
It's a simple 1, 2, 3 step to get all the facts on fire protection in the Refinery Catalog.

Here's all you do...

1. ***Check the index,*** you'll find Rockwood Fire Protection Equipment conveniently listed.



2. ***Read the section,*** you'll get the facts on 15 types of Rockwood Fire Protection equipment, including the engineering data of each.



3. ***Write or phone for more facts*** and Rockwood will quickly send you the information you desire.

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Engineers Water... to Cut Fire Losses

ROCKWOOD

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each of these weeks is approximately $1.65, $1.50, $1.32, and $1.40 respectively. Since the refinery employe has already received straight-time compensation on a salary basis for all hours worked *only* additional halftime is due.

For the first week, this employe should be entitled to be paid $66; for the second week $69 ($66 plus 4 hours at 75 cents or 40 hours at $1.50 plus 4 hours at $2.25); for the third week $72.60 ($66 plus 10 hours at 66 cents or 40 hours at $1.32 plus 10 hours at $1.98); for the fourth week approximately $70.90 ($66 plus 7 hours at 70 cents or 40 hours at $1.40 plus 7 hours at $2.10).

4. Day and Job Rate Employes. If an employe is paid a flat sum for a day's work for doing a particular job, without regard to the number of hours worked in the day or at the job, and if he receives no other form of compensation for services, his regular rate should be determined by totaling all the sums received at such day or job rates in the workweek and then by dividing by the total hours actually worked. He should then be entitled to extra half-time pay at this rate for all hours worked in excess of 40 in the week.

5. Employes Working at Two Rates. If an employe in a single workweek works at two or more different types of work for which different basic hourly rates of not less than $1 an hour have been established, his regular rate for that week is the weighted average of such rates.

6. Excluded Pay. The following payments are considered to be *excluded* from the "regular rate" as provided for by the so-called statutory exclusions:

A. Sums paid as gifts made at Christmas time or on other special occasions

B. Payments for unworked time due to vacation, holiday, illness, or failure of the employer to provide sufficient work for the employe

C. Payments determined at the discretion of the employer and not

Stop Product Losses Through Leaking Pressure Relief Devices!

Get A "Bottle-Tight" Seal With BS&B *Safety Heads!*

Product loss in a processing or transfer system can often be traced to leaking pressure relief valves. To make matters worse, it may be extremely difficult to make repairs that will stop this loss with any degree of permanence.

In hundreds of such cases BS&B Quik-Sert Safety Heads, installed upstream and in series with the leaky relief device, have provided the perfect solution to the problem. Pressure relief accuracy is in no way impaired . . . in some cases it is actually improved.

When pressure in the system is bled back to normal, the valve is free to close as usual. The BS&B Quik-Sert Safety Head can be replaced in a matter of minutes at any later convenient time.

If you need a leak-tight pressure relief assembly for normal operation of your pressured systems, BS&B Safety Head specialists will gladly survey your installation and submit recommendations.

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Kansas City 26, Missouri
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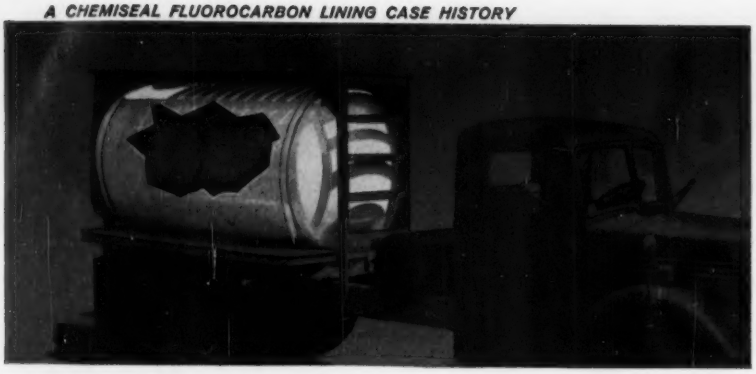
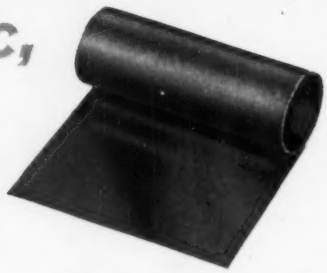
For more data on advertised products, use Readers' Service Cards, last page.

A CHEMISEAL FLUOROCARBON LINING CASE HISTORY



Wyman-Gordon *finds economical answer to handling*

Hydrochloric, Hydrofluoric, Nitric Acids



Chemiseal Fluorocarbon Linings are chemically-inert, tough, and withstand heat and cold (−320° F. to +250° F.).

A CHEMISEAL FLUOROCARBON PLASTIC LINING is used on this truck owned by Wyman-Gordon of Worcester, Massachusetts to assure safe, economical haulage of waste acids. Since April, 1957 the truck has been in continuous service carrying 80% hydrochloric, 13% hydrofluoric, and 7% nitric acid between the company's two Closed Die Forging plants and the disposal area. And the lining is still in perfect condition.

You can make your present plant equipment impervious to acids by applying CHEMISEAL Fluorocarbon Plastic Linings. They can be cemented over most contours and to most materials—metal, wood, concrete, etc. And, to make protection complete, seams are heat fused into a continuous, chemically-inert surface.

CHEMISEAL Fluorocarbon Plastic Linings are available through certified applicators, equipped with factory-trained personnel and specialized equipment. Call the applicator nearest you for more information:

THE BARBER-WEBB COMPANY, INC., LOS ANGELES, CAL.
BELKE MFG. CO., INC., CHICAGO, ILLINOIS
BUCKLEY IRON WORKS, DORCHESTER, MASS.
ELECTRO-CHEMICAL ENGRG. & MFG. CO., EMMAUS, PA.
LINCO, INC., HOUSTON, TEXAS
METALWELD, INC., PHILADELPHIA, PA.

Or write for Bulletin AD-152. Special Products Dept., United States Gasket Company, Camden 1, New Jersey.

United States Gasket *Plastics Division of* GARLOCK

made by any prior contract or premise causing the employe to expect such payment

D. Contributions to pension, retirement or old-age, life, accident or health insurance plans

E. Premiums for work above daily or weekly standards such as eight hours in a day or 40 in a workweek

F. Premiums for work on Saturdays, Sundays, holidays, regular days of rest, or sixth or seventh days of the workweek

G. Premiums for work outside the regular workday and workweek and not as a result of an employment contract or collective-bargaining agreement.

Other Considerations. Where a refinery employe incurs expenses on his employer's behalf, reimbursement for such expenses is not included in the employe's regular rate because such payment is not compensation for services rendered.

For example, payment by way of reimbusement for the following types of expenses should not be regarded as part of the refinery employe's regular rate.

1. Actual amount expended in purchasing supplies, tools, materials, or equipment on behalf of his employer

2. Actual or reasonably approximate amount expended in purchasing, laundering or repairing uniforms or special clothing which his employer requires him to wear

3. Actual or reasonably approximate amount expended by an employe, who is traveling over the road on his employer's business, or transportation, and living expenses away from home, including taxicab fares

4. Supper money, a reasonable amount given to a refinery employe, who ordinarily works the day shift and can ordinarily return home for supper, to cover the cost of supper when he is requested by his employer to continue work during the evening hours in a refinery.

Obviously, the Act takes a single workweek as its standards and does not permit averaging of hours over two or more weeks. For example, if a refinery employe works 30 hours one week and 50 hours the next, he

For more data on advertised products, use Readers' Service Cards, last page.

A TWO-MINUTE STORY THAT CAN SAVE YOUR COMPANY THOUSANDS OF DOLLARS

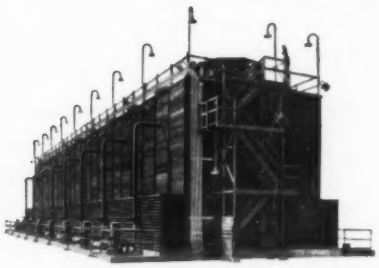
What the old timer said to the young engineer about buying cooling towers

"Buy 'em big, young man. That's the only way you can be sure the tower will handle your job."

"Isn't that expensive?" asked the young engineer. "Why can't we specify the exact capacity we need and get bids on the proper size tower? Seems like we would save money."

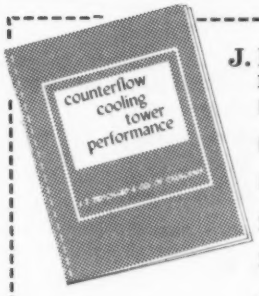
"Not enough known about tower performance, so play it safe and buy it big."

The Old Timer has a point. And, until now, he was forced to abide by it – forced to buy in the dark and pay the penalty of over-buying to protect his company. But there's been an important change. Now, for the first time, all of the information needed to determine counterflow cooling tower performance is available in one easy-to-use handbook.



Ask Pritchard to bid on the next cooling tower you need – then check our figures using the Performance Handbook. You'll see in black and white how a Pritchard Cooling Tower gives you more value for your money.

This handbook, entitled "Counterflow Cooling Tower Performance" also can be used to check tower selections before you buy. It contains technical data and charts prepared by leading authorities in cooling tower design. It's available from Pritchard for $3.00. Mail coupon below and check or money order for your copy.



J. F. PRITCHARD & CO. OF CALIFORNIA
Dept. 111, 4625 Roanoke Parkway, Kansas City 12, Mo.

- ☐ Enclosed is $3.00. Please send copy of "Counterflow Cooling Tower Performance"
- ☐ Please send free copy of new Counterflow Cooling Tower Bulletin 4.9.080A
- ☐ Please have your representative call on me

Name ..... Title .....

Firm .....

Address .....

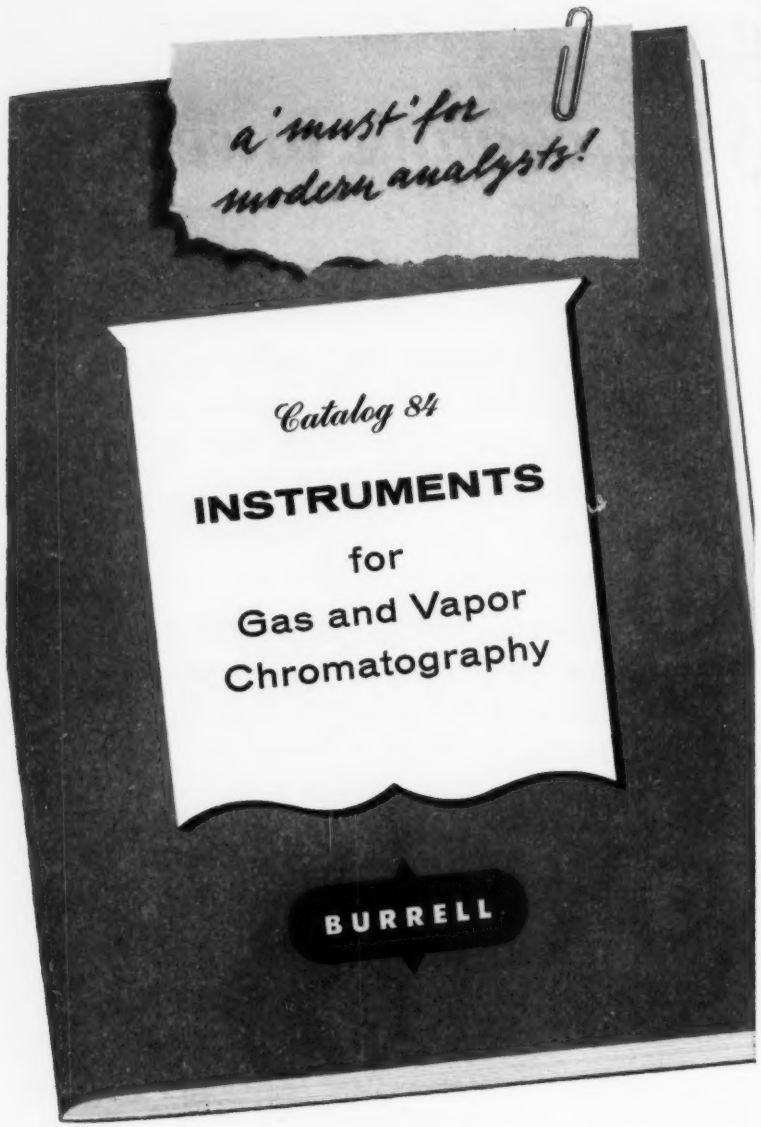
City ..... Zone ..... State .....

For more data on advertised products, use Readers' Service Cards, last page.

"For Scientists Everywhere"

Important new booklet

Now, for the first time in the dynamic history of modern chromatographic analysis, you can have a complete listing of instruments and accessories in one handy volume.



Only Burrell builds a complete series of laboratory instruments for chromatographic analysis, including four models of the versatile Burrell Kromo-Tog for research or process control.

Request Catalog 84

BURRELL *Scientific Instruments and Laboratory Supplies*

BURRELL CORPORATION, 2223 FIFTH AVENUE, PITTSBURGH 19, PA.

must receive overtime compensation for the 10 overtime hours worked in the second week, even though the average number of hours worked in the two weeks is 40.

Most Expensive Item. In every refinery, labor costs are often the largest single component of the cost of doing business. Thus, the control of these labor costs is one of the most important parts of a plan for economical production. You must keep records to show the results of the dollars spent for labor so that intelligent decisions may be made in the area of refinery production and selling policies.

You can see, therefore, that while overtime cost is expensive enough without making it more so by mistakes in figuring, the objectives of accounting for your refinery labor costs may be summaried as follows:

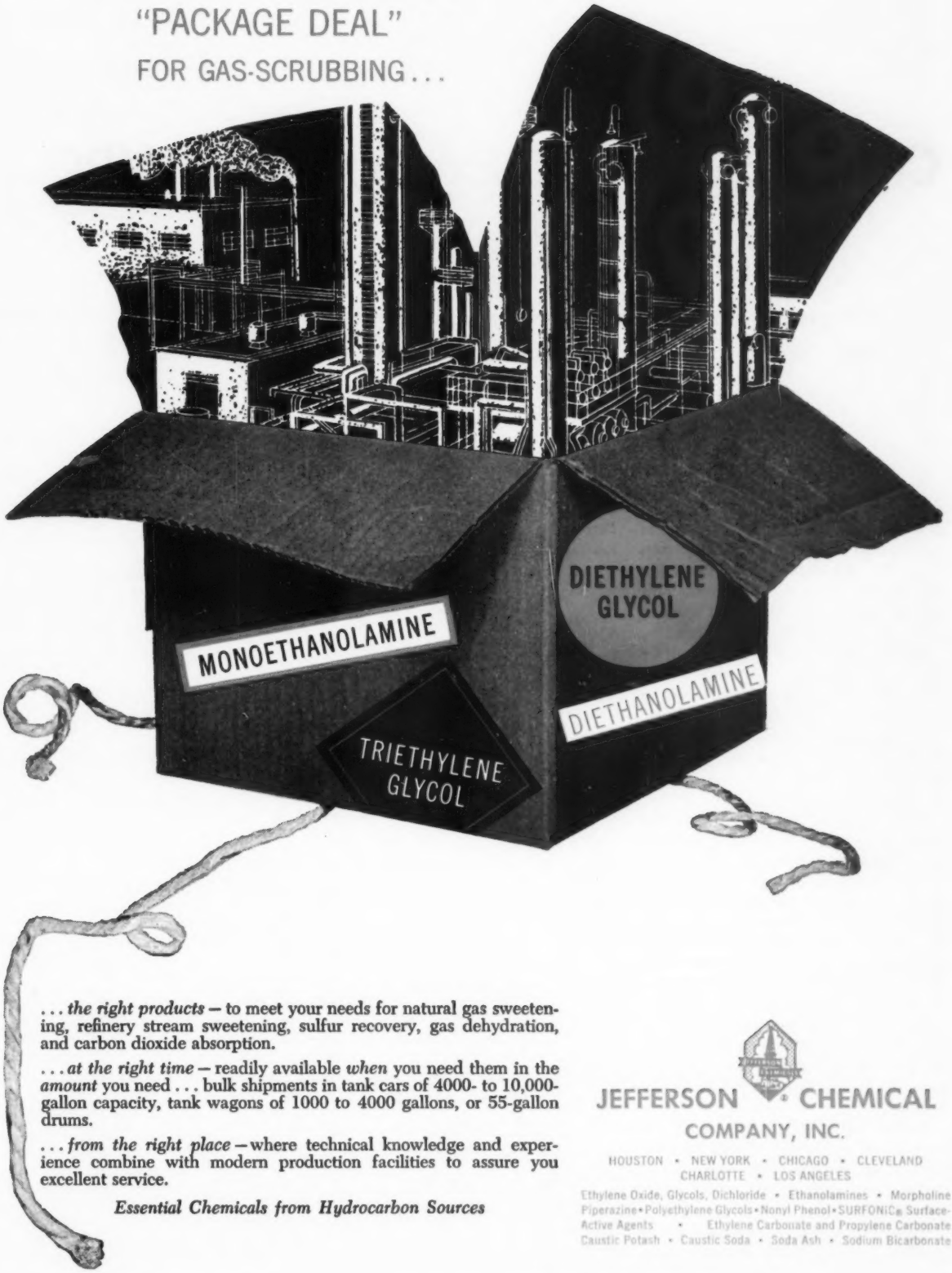
1. To assign labor costs to specific jobs, processes, or activities, in order to provide a basis for the direction of production and selling policy
2. To provide for accurate and prompt payments to your refinery employes in a way which will be most satisfactory to them
3. To fulfull wage-hour requirements and provide a basis for the preparation of required accounting reports.

The first step in reducing your refinery labor costs is to determine what they are at present, then you have a standard to operate against. These pointers should then help you compute and control your refinery overtime costs. ##

About the Author

Robley D. Stevens is a Washington correspondent and management consultant specializing in public, labor, and personnel relations. He is a former representative of the Labor department and was connected with the Army and Navy departments in civilian capacities. He has written two books on labor relations, and one on government, "Your Government Guidebook," just published by W. A. Wilde Co., Boston. Also an author of a number of magazine articles on labor relations, Stevens holds LL.B. and LL.D. degrees from Blackstone School of Law.

HERE'S JEFFERSON CHEMICAL'S "PACKAGE DEAL" FOR GAS-SCRUBBING...



... *the right products* – to meet your needs for natural gas sweetening, refinery stream sweetening, sulfur recovery, gas dehydration, and carbon dioxide absorption.

... *at the right time* – readily available *when* you need them in the *amount* you need ... bulk shipments in tank cars of 4000- to 10,000-gallon capacity, tank wagons of 1000 to 4000 gallons, or 55-gallon drums.

... *from the right place* – where technical knowledge and experience combine with modern production facilities to assure you excellent service.

Essential Chemicals from Hydrocarbon Sources

JEFFERSON CHEMICAL COMPANY, INC.

HOUSTON • NEW YORK • CHICAGO • CLEVELAND
CHARLOTTE • LOS ANGELES

Ethylene Oxide, Glycols, Dichloride • Ethanolamines • Morpholine
Piperazine • Polyethylene Glycols • Nonyl Phenol • SURFONIC® Surface-Active Agents • Ethylene Carbonate and Propylene Carbonate
Caustic Potash • Caustic Soda • Soda Ash • Sodium Bicarbonate

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening...

Crowd of 30,000 Expected for WPC

Congress will feature 200 reports, many covering new refining processes and petrochemical trends

Some 30,000 technical and scientific personnel in the petroleum and petrochemical fields are expected to swarm into New York City Coliseum from May 30 to June 5 to attend the fifth World Petroleum Congress. This will include more than 7,000 delegates, many from foreign countries.

In all, 200 scientific reports will be presented. Among other things, the Congress will delve into the need to develop new sources of oil supplies. The importance of this is reflected by the fact that Europe's consumption of petroleum is rising at an annual rate of about six percent.

New refining processes which are being developed and installed to meet the rising demand for oil products in various parts of Europe will be covered. Research now underway leading to numerous new oil products that will be manufacturer and marketed in Europe and elsewhere, (particularly in the petrochemicals field) will also be discussed. Developments in plastics, particularly polyethylene, synthetic rubbers, and synthetic detergents, were cited as examples of the expanding interest in chemicals-from-oil in Europe.

In the field of refining processes, the papers will reflect intense interest in high octane motor fuels giving more energy per gallon—thus conserving crude oil resources.

Of most interest to those in the oil, gas, and petrochemical industries are Section 3, "Oil Processes and Refining"; and Section 4, "Chemicals from Petroleum and Natural Gas." The following list shows all papers to be presented in both:

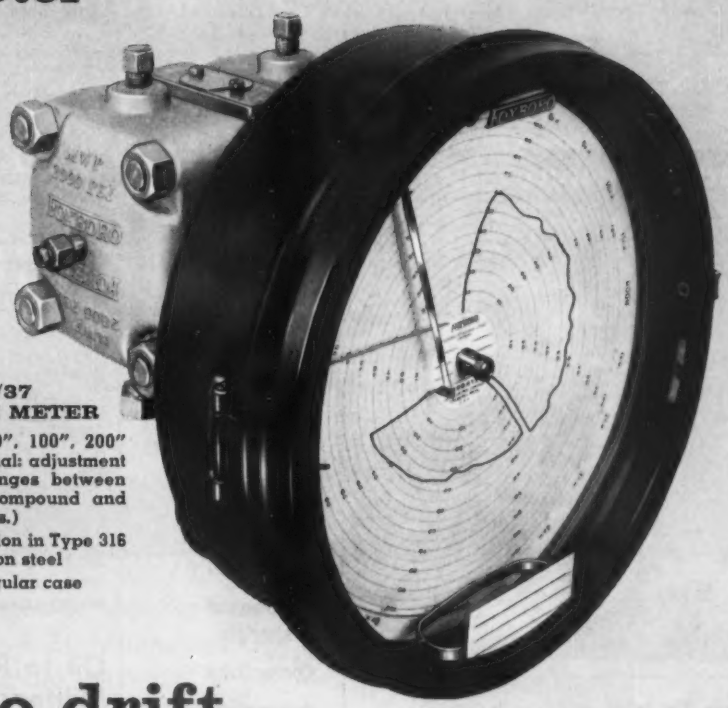
SECTION 3.

1. The Refiner Looks at Cars of the Future, The Atlantic Refining Co.
2. Processing Needs for Higher Quality Fuels, Universal Oil Products Co.
3. A New Isomerization Process, Esso Research & Engineering Co.
4. Reactions in Catalytic Reforming of Naphthas, Standard Oil Co. (Indiana); Esso Research & Engineering Co.
5. Hydrogenation of Petroleum Fractions, Union Oil Co. of California.
6. The IFP Hydrorefining Process for Crude Oils and Petroleum Fractions, Institut Francais du Petrole.
7. Cobalt Molybdenum Catalysts for Hydrodesulfurization and Reforming of Petroleum Fractions, Stazione Sperimentale Per I Combustibili; S.p.A. per l'Industria Petrolifera e Chimica; Societa Petrolifera Italiana.
8. Studies on a Commercial Two Stage Catalytic Cracking Plant, Shell Oil Co.
9. Catalysts Based on Montmorillonite Mineral, Sudchemie AG.
10. Study of the Nature of Activity of Alumosilicate Catalysts, Professor K. V. Topchieva, et al.
11. Chemical Changes in Lubricating Oil on Hydrofining, Imperial Oil, Ltd.
12. Hydrofining in the Manufacture of Bright Stock, Esso Standard S. A. Francaise.
13. Catalytic De-Aromatization of Light Distillates and the Hydro-Finishing of Lubricating Oils, Societe Francaise des Petroles BP.
14. Production of Lubricating Oils and Paraffin from Sulfurous Oils in the U. S. S. R., Professor L. G. Zherdeva, et al.
15. Dehydrogenation of Naphthenic Lubricating Oil Fractions, Lobitos Oilfields, Ltd.
16. Sweetening of Petroleum Products by Catalytic Oxidation with Sulfur Dyes, Compagnie Francaise de Raffinage.
17. Treating Aromatic By-Product Gasoline from Thermal Conversions by the BASF-Scholven Process for Light Oil Refining, Badische Anlin & Soda-Fabrick AG.
18. Development in Treating Processes for the Petroleum Industry, Koninklijke/Shell Laboratorium.
19. Refinery Studies by Digital Computer, Tidewater Oil Co.
20. Economic Studies of Refining Problems by Means of Modern Electronic Computers, Societe des Petroles Shell Berre.
21. Conjunct Polymerization of Ethylene with Heteropolyacid Catalysts, Delft Technical University.
22. Extraction of Aromatics with Sulfolane, Shell Development Co.
23. Gasoline Refining Using Adsorbents Selective for n-Paraffins, Standard Oil Co. (Ohio).
24. Elementary Processes of Mass Transfer in Extraction, Absorption and Distillation, Institute of Chemical Technology, Braunschweig.
25. The Use of Gaseous Sulfur Trioxide in the Sulfonation of Petroleum Oils, Manchester Oil Refinery, Ltd.
26. Refining of Steam Cracked Gasoline, The British Petroleum Co., Ltd.
27. Twenty-Five Years with Fischer-Tropsch Fixed Bed Catalyst, its Present Standing and Possibilities for the Future, Ruhrchemie AG.
28. The Fluid Coking Process—Commercial Experience to Date, Esso Research & Engineering Co.; Tidewater Oil Co.
29. Processes for Continuous Thermocontact Treatment of Oil Stocks on Coke, Professor B. K. Amerik, et al.
30. Catalytic Processing of Residual Fuel Stocks, Houdry Process Corp.

SECTION 4.

1. Manufacture and Utilization of Aromatics from Petroleum, Humble Oil & Refining Co.
2. Two-Stage Process for Production of Naphthalene and High Octane Gasoline from Cycle Stock, Sinclair Research Laboratories, Inc.
3. Catalytic Dehydrocyclization of Paraffinic Hydrocarbons, Professor B. A. Kazansky; Professor A. L. Liberman.
4. Kinetics of Pyrolysis of Ethane at Practical Conversions, Union Carbide Chemicals Co.
5. Fundamental Relations of the Pyrolysis of Hydrocarbons to Acetylene and Ethylene, Farbwerke Hoechst AG.
6. Acetylene Production from Pyrolysis of Liquid Hydrocarbon Feedstocks, Societe Belge de l'Azote et des Produits Chimiques du Marly; M. W. Kellogg Co.
7. Oxidative Cracking of Propane and Butane-Isobutane Mixtures, University of Pisa.
8. Cracking of Gaseous Hydrocarbons by Partial Oxidation, Badische Anilin & Sodafabrick AG.
9. Catalytic Synthesis of Cyclopentadiene Hydrocarbons, Professor N. I. Shuikin; Professor T. I. Naryshkina.
10. Butadiene Production—Commercial Practice with Dow Catalyst, Dow Chemical Co.
11. A Process for Manufacturing Isoprene, Institut Francais du Petrole.
12. Manufacture of Conjugated Diolefins by Hydroperoxidation of Olefins, Institut Francais du Petrole.
13. The Production of Synthesis Gas by Partial Oxidation, The Texas Co.
14. Recent Developments in the Oxo Process, Gulf Research and Development Co.
15. Synthesis of Higher Aliphatic Alcohols by Direct Oxidation of Paraffinic Hydrocarbons, Professor A. N. Bashkirov; Professor V. V. Kamzolkin.
16. Hydrogen Peroxide—New Techniques for its Utilization, Shell Development Co.
17. A New Process for Oxidation of Aromatics, Standard Oil Co. (Indiana).
18. Production of Aromatic Dicarboxylic Acids, Koninklijke/Shell Laboratorium; N. V. De Bataafsche Petroleum Maatschappij.
19. Acetic Aldehyde as Raw Material for Acrylonitrile. The Knapsack Process, Knapsack Griesheim AG.
20. Detergent Alkylsulfonates Derived from Petroleum Hydrocarbons through Hydroperoxides, Kadimah Chemical Corp.
21. Relationship Between Structure of Phenyldodecane Isomers and Performance as Detergent Base Materials, Koninklijke/Shell Laboratorium; N. V. De Bataafsche Petroleum Maatschappij.
22. Polymers of Ethylene—Two Decades of Prog-

unmatched stability in a "dry" flow meter



FOXBORO T/37 DIAPHRAGM METER

- **Ranges: 20", 50", 100", 200" standard (Optional: adjustment for full scale ranges between 25" and 200"; compound and expanded ranges.)**
- **Forged construction in Type 316 stainless or carbon steel**
- **Round or rectangular case**

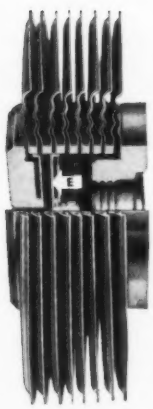
No zero drift... Complete overrange protection

Mercuryless flow measurement over a wide range of differential pressures — at static pressures up to 2000 psi (2500 psi optional). That's the story behind Foxboro's unique Type 37 Diaphragm Flow Meter.

No matter how often you check its accuracy you'll find no need to reset zero or span. Four vital construction features assure this remarkable stability:

1. Unique nesting diaphragm element of Type 316 S.S. which responds to changes in pressure with unmatched sensitivity yet cannot be damaged by overrange . . .
2. Packless drive bar which transmits precise linear motion to pen arm without "hang-up" . . .
3. Bi-metallic temperature compensator which precisely counteracts changing volume of the filling fluid . . .
4. Heavy Ni-span C alloy range springs which are unaffected by changes in line temperature . . .

Get full details on this high utility, completely dependable dry flow meter. Write for Bulletin 7-15A. **The Foxboro Company, 744 Neponset Ave., Foxboro, Mass.**



Type 316 S.S. diaphragm elements, in both high and low pressure chambers, provide greatest linearity and freedom from hysteresis. Nesting design, and integral spacer rings provide positive overrange protection. Bi-metallic temperature compensator (E) adjusts the capacity of the diaphragm assembly to counteract changing volume of the filling fluid.

FOXBORO
REG. U.S. PAT. OFF.
first in flow metering

For more data on advertised products, use Readers' Service Cards, last page.

Happenings . . .

ress in Control of Structure, E. I. du Pont de Nemours & Co.
23. New Plastics from Petroleum, Montecatini Co.
24. New Classes of Plastic, Rubbers, and Textile Fibers from Petroleum, Instituto di Chimica Industriale Politecnico di Milano.
25. Some Relationships of Polymerization of Alpha-Olefins on Complex Metal-Organic and Oxide Catalysts, Professor A. V. Topchiev; Professor B. A. Krentsel.
26. Polymerization of Acetylene and Homologs, Phillips Petroleum Co.
27. Oil Extension of Synthetic Rubbers, Polymer Corp.
28. Summary of the Synthetic Fiber Industry, Chemstrand Corp.
29. Improved Process for Sulfur Recovery from Refinery Gases, The Atlantic Refining Co.
30. Thianaphthene and Homologs from Hydrocarbons and Hydrogen Sulfide, The Texas Co.
31. Integration of Petroleum Chemicals Operations, Imperial Chemical Industries, Ltd.

Import Plan Regulations Spell Out OIA Function

New imports regulations established by the Oil Import Administration provide a post limit of 757,100 bpd for crude and unfinished oils, except residual, in Districts one through four, and a companion limit of 211,000 bpd for District five. The new regulations spell out administrative structure of the OIA, describes licensing procedure, set rules for exchanges, provide penalties for those who violate restrictions, set up a three-man appeals board, and set forth other highlights of the program.

Esso, Amoco Lay Off At Texas City, Baton Rouge

Esso Standard Oil Co. discharged 440 of its Baton Rouge refinery employes March 6. A decrease in the backlog of construction work was given as reason for the layoff. The company said employes received "generous" severence allowances, pay for vacations not taken, and two weeks pay in lieu of bonuses. Early retirement was offered 53 of those affected. All employes were in what the company calls "mechanical work force," and no skilled employes were involved. American Oil Co. at Texas City followed suit in reducing its work force by 144 to "institute a number of steps in the company methods improvement program." The company said some work assignments where there has been duplication of effort will be combined.

Oilmen Describe Radiation To Atom Energy Committee

Less than one percent of permissible radiation exposure has been received by Esso Research and Engineering Co. employes, according to the company. Esso's Dr. James F. Black told the Joint Committe on Atomic Energy, which is conducting hearings into employe radiation hazards in U.S. industry and possible need for a special Federal workman's compensation law, that safety depends upon (1) selecting the right individual for the job, (2) providing proper equipment, and (3) providing employes with proper training and information.

Oil to Remain Prime Military Fuel Source

Hydrocarbon fuels will continue to be our primary source of energy through this century, predicts J. B. Macauley, deputy director, Defense Research & Engineering. He told WPRA members at the 47th annual meeting that (1) the military is searching for an omnivorous engine that could use varied fuels, (2) it is unlikely that military octane requirements will increase "substantially," (3) that nuclear fuel will be used on all submarines and "a few surface ships but isn't imminent for ground vehicles or even aircrafts, and (4) that future plans call for running naval gas turbine and diesel engines on distillate fuels. He added that the space age will usher in many new lubricant problems, and that regarding propellants "there is a noticeable increase in attention to storable liquids of late."

Ike Asked to Eye Cost of Asphalt in Road Program

President Eisenhower has been asked to urge a comparative study of asphaltic concrete and portland cement for use in the Federal Interstate Highway System, by L. W. Moore, president of American Oil Co. He wrote the President, "I firmly believe that if you request the appropri-

New handy refractory guide

Here are a few of the technical factors covered...

Abrasive qualities
Acid resistance
Coefficient of expansion
Composition
Compressive strength
Conductivity
Drying shrinkage
Fusion point
Modulus of rupture
Selling properties
Temperature limit

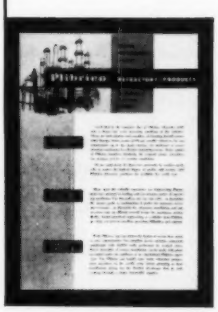
All the facts you need to select the right refractory for every operating condition in the refinery industry

Every physical and performance characteristic of refractories specially selected from Plibrico's complete line is charted for your quick reference.

You'll find grades of Plicast castable refractory with exactly the properties you need...the temperature range, the abrasion resistance, the insulation value. You'll also find select grades of the original plastic refractory, Plibrico Jointless Firebrick, for *any* operating condition.

See how Plibrico provides unified responsibility through complete service...including products, engineering and installation.

WRITE FOR FREE REFERENCE CHART #76 giving detailed data on products for refinery process linings or consult your local Plibrico Field Engineer for technical assistance.



9219

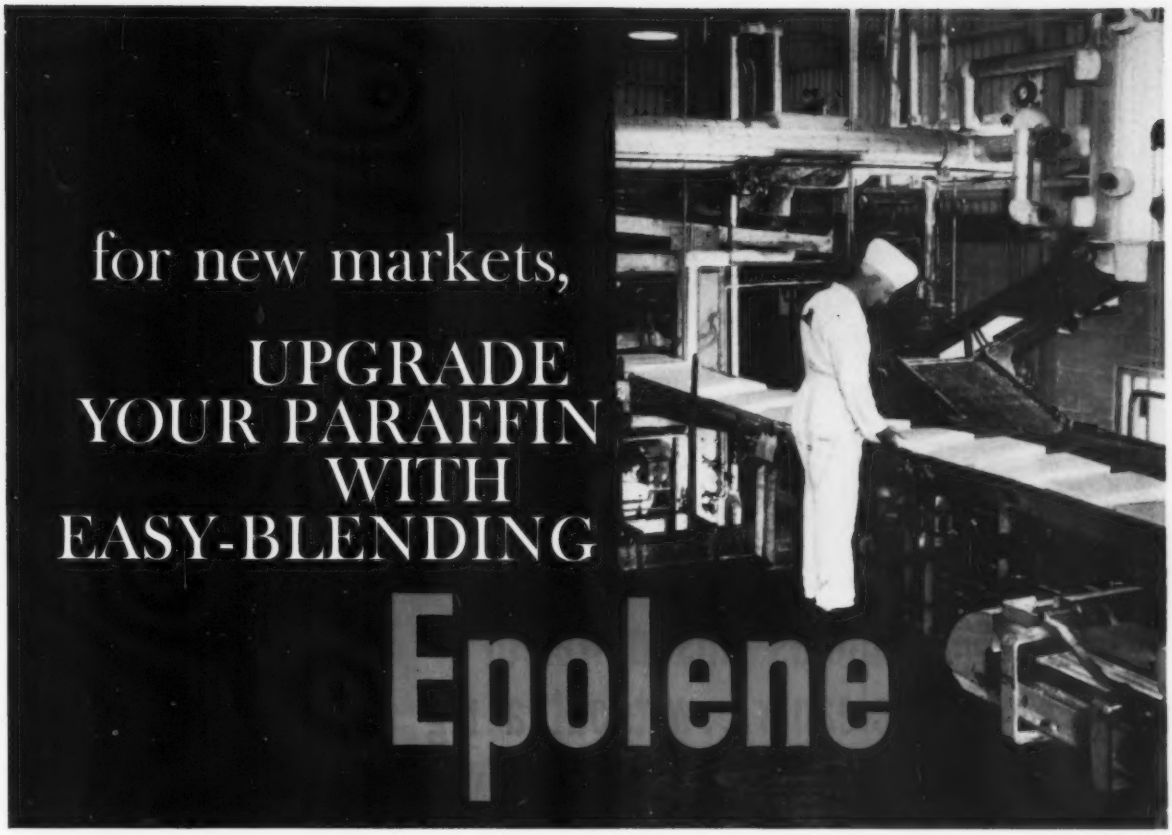
Plibrico REFRACTORIES

Serving the Furnaces of Industry 24 Hours a Day

PLIBRICO COMPANY, 1812 Kingsbury, Chicago 14

Plibrico Sales & Service in Principal U. S. Cities & Canada

REFRACTORY PRODUCTS · ENGINEERING · CONSTRUCTION



Paraffin producers are blending their way to new and profitable markets with Epolene, Eastman's low-molecular-weight polyethylene resins.

Paraffin modified with Epolene has superior abrasion resistance, higher gloss. Epolene improves resistance to flaking and cracking, too, by providing better adhesion and greater flexibility. Other benefits: higher blocking temperatures and resistance to thermal shock.

Epolene is available in four types. All are supplied as small, white pellets for easy handling, rapid blending. These resins range in molecular weight from 1,500 to 6,000 and possess varying degrees of linearity (densities 0.907 to 0.935), providing paraffin formulators with a choice of performance characteristics to meet a variety of processing and end-use requirements.

For further information and samples of these Eastman low-molecular-weight polyethylene resins, or for assistance in evaluating Epolene in your paraffin products, call our nearest representative or write Eastman Chemical Products, Inc., subsidiary of Eastman Kodak Company, Chemical Division, Kingsport, Tennessee.

Physical Properties of Epolene

Property \ Type	N	E*	C	LV
Ring and Ball Softening Point, °C	106	105	101	103-4
Color, Gardner scale, max.	2	2	2	2
Viscosity @ 212°F (2% blend in 130°F paraffin), cps.	4.4	4.1	4.9	4.0
Cloud point (2% blend in 130°F paraffin), °F	181	180	164	172

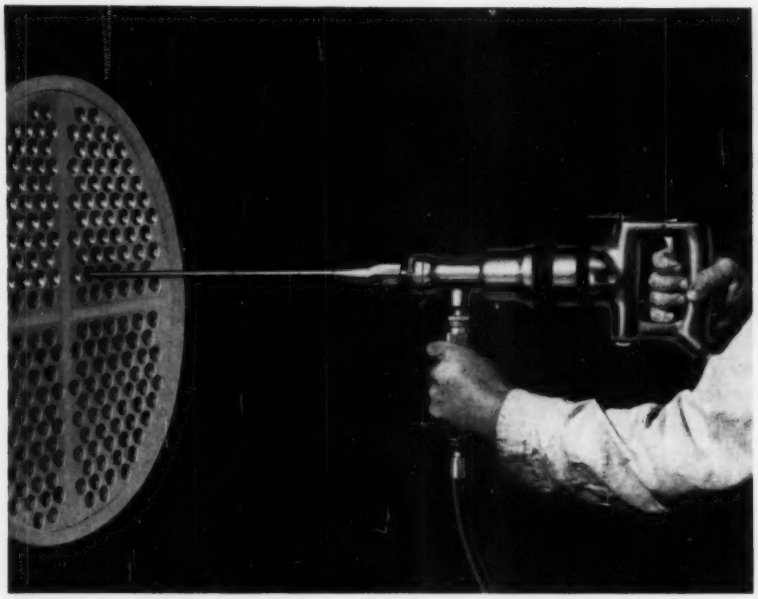
*emulsifiable

Epolene

EASTMAN LOW-MOLECULAR-WEIGHT POLYETHYLENE RESINS

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tennessee; Atlanta; Chicago; Cincinnati; Cleveland; Framingham, Massachusetts; Greensboro, N. C.; Houston; New York City; St. Louis. **West Coast: Wilson Meyer Co.,** San Francisco; Los Angeles; Portland; Salt Lake City; Seattle.

For more data on advertised products, use Readers' Service Cards, last page.



One man handles this powerful Airetool tube cleaner...without a rig

There's no other tool like this Airetool Model CC-475 heat exchanger and condenser tube cleaner. It weighs just 10 lbs. One man handles it easily — without a supporting rig. Yet, it's powerful enough to clean all severely clogged tubes up to 1″ diameter. Built-in flushing system washes away debris, cools drill head — keeps work moving at a fast pace.

You get this same time and cost-saving performance from Airetool straight tube cleaners and pneumatic, as well as electric tube expansion control systems. Write for Bulletin 66. *The Airetool Mfg. Co., Springfield, Ohio*

BRANCH OFFICES:
New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.

REPRESENTATIVES
in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.

EUROPEAN PLANT:
Vlaardingen, The Netherlands

CANADIAN PLANT:
Brantford, Ontario

Happenings . . .

ate agency of the government to study the comparative economical advantages of asphaltic concrete, very substantial savings could be made in the road-building program." Moore cited cost comparisons based on bid prices for the New Jersey Turnpike that "showed a saving of $46,000 per mile by using heavy duty asphaltic concrete rather than portland cement."

Computer Process Control Applied in Pilot Plant

The first computer-operated control system for continuous processing has been successfully applied to a pilot plant by Universal Oil Products Co. and Daystrom, Inc. The accomplishment, result of several years' research by the two firms, "is expected to broaden applications for continuous applications by controlling operations too complex for previously available systems."

Gulf Strike Ends With One-Year 5% Contract

Gulf Oil Corp.'s 285,000-bpd Port Arthur refinery returned to production on March 3, ending a 32-day strike by OCAW Locals. A five percent wage increase, retroactive to January 16, was provided for in a contract ratified by OCAW Membership. The agreement reportedly gives management "more flexibility" in manning units and fixing job classifications, but the clause will cause no "impairment of traditional craft lines." The company agreed to several union proposals for resolving seniority and departmental problems.

Indiana Standard Gets "Minuteman" ICBM Contract

Special-purpose solid fuels and equipment for the "Minuteman," first all solid-fuel intercontinental ballistic missile will be developed for the Air Force by Standard Oil Co. (Ind.). The company will develop fuels and metal parts for gas generators to operate auxiliary power units. Most of the work will be done at expanded facilities at Seymour, Ind.

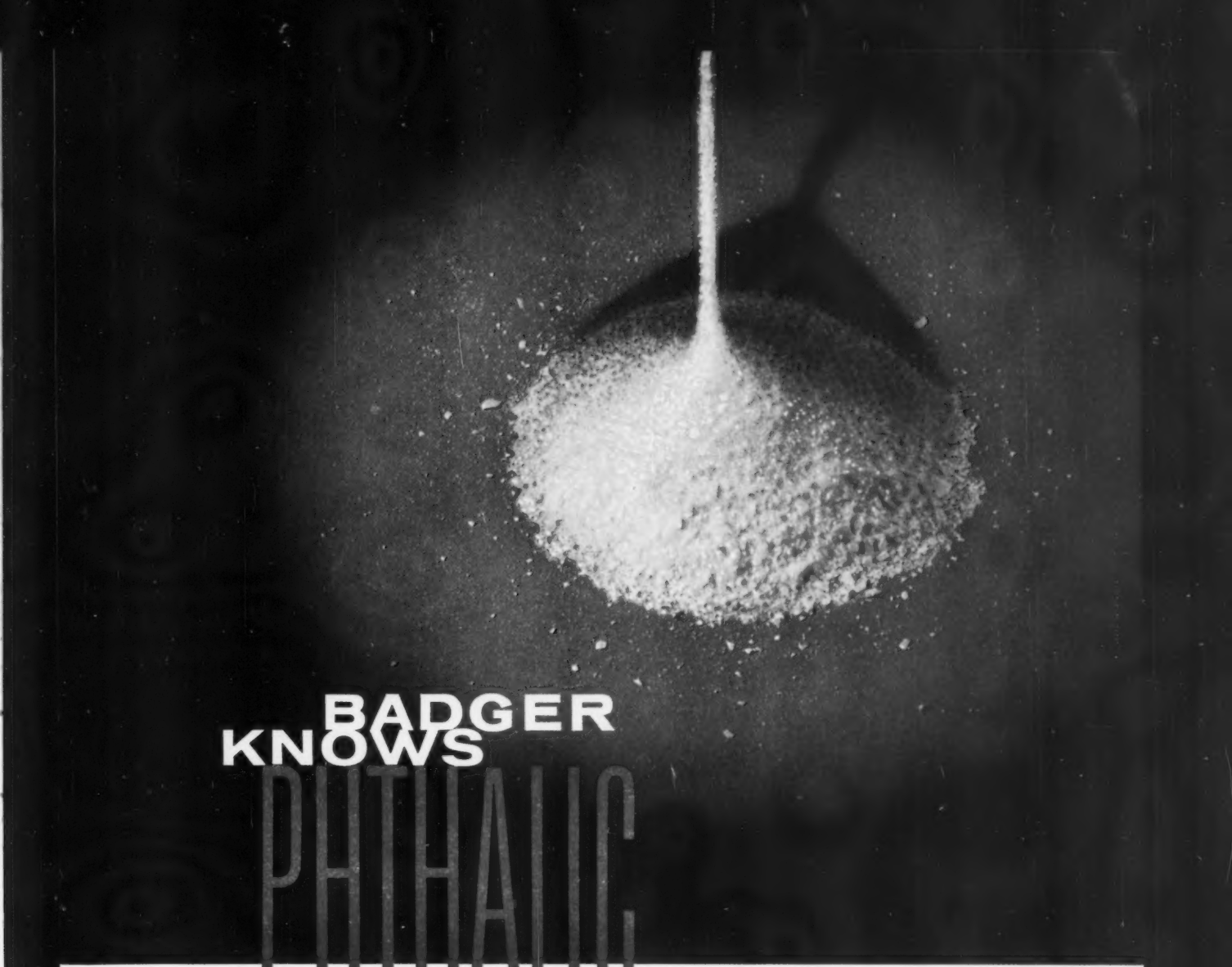
France Shows 1958 Gains In Refining Capacity

Refinery capacity in France rose to 710,900 bpd in 1958 from 669,700 bpd in 1957, according to a report of Comite Professional du Petrole, a refining and marketing trade group. Refinery runs in 1958 averaged 595,760 bpd compared with a 1957 average of 499,300 bpd.

Natural Gas Liquids Set Daily Production Records

Natural gas liquids production, at an average of 36.2 million gallons per day in December, was the highest ever recorded at five percent above December, 1957, says the Bureau of Mines. Produc-

For more data on advertised products, use Readers' Service Cards, last page.



BADGER KNOWS PHTHALIC

AN EXCLUSIVE FLUID BED PROCESS... ENGINEERING, CONSTRUCTION AND OPERATING EXPERIENCE... ALL AVAILABLE FROM BADGER

Badger is now sub-licensing the fluid bed catalytic process originally developed by The Sherwin-Williams Company for its own successful phthalic anhydride plant.

Numerous refinements have been contributed to the process by Badger. These include new purification techniques, better reactor design (including more efficient heat removal), improved condensing and recovery sections for effluent gases. The process has these advantages over conventional fixed bed methods: *Low capital and operating costs* — smaller, simpler equipment saves 20% or more on plant investment, cuts utility and operating labor costs up to 30%. *Better yield* — process converts 5-10% more of feed naphthalene to phthalic anhydride. *Flexibility* — throughput may be varied over a wide range; process is easy to control. *Highest product quality* — heat color stability is high due to fewer impurities. *Safety* — fluid bed reactor virtually eliminates possibility of explosion.

With the process Badger offers unmatched engineering, construction and operating experience . . . gained in working with Sherwin-Williams . . . from the design and engineering of two current phthalic anhydride projects (see right) . . . through a broad background in fluid bed processes in general. It's as simple as this: when you are considering new phthalic anhydride facilities, come to Badger for the answers. Write or call Badger Manufacturing Company, 363 Third Street, Cambridge 42, Massachusetts.

Two major phthalic anhydride projects current at Badger

At Elizabeth, N. J., Badger is constructing a 30 million lb/yr phthalic anhydride plant for Reichhold Chemicals, Inc. When completed in late 1959, it will produce about 16% of U. S. production of phthalic anhydride made from naphthalene.

Another fluid bed plant, similar in design and capacity to RCI's, is being handled for ACNA (a subsidiary of the Montecatini group) in Milan, Italy. This plant is also scheduled to go on-stream in 1959.

built by **BADGER**

INTERNATIONAL DESIGNERS
ENGINEERS • CONSTRUCTORS

THE BADGER COMPANIES

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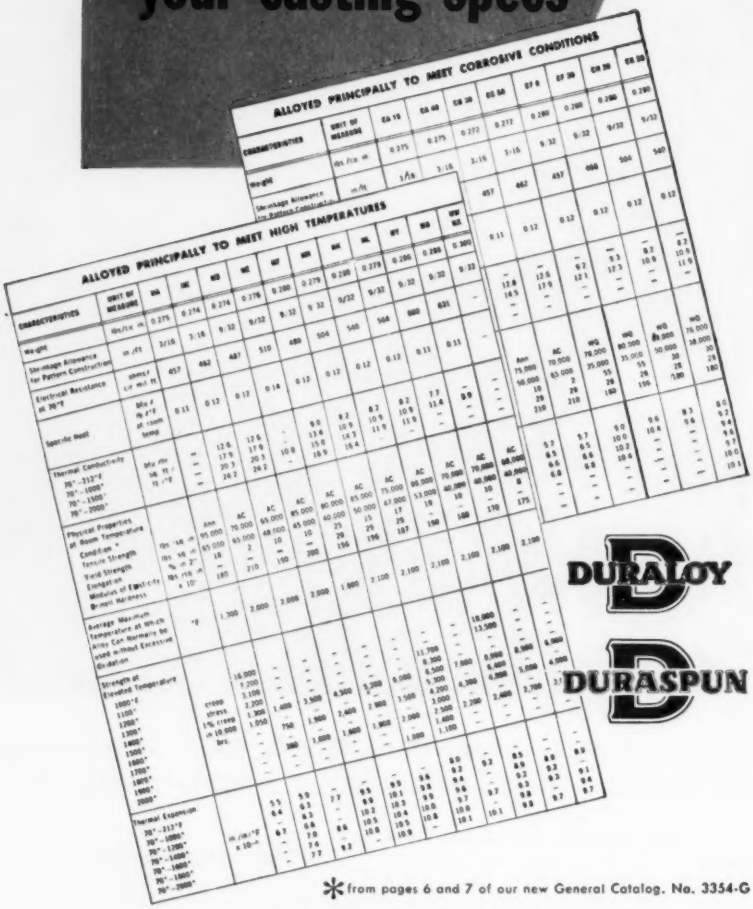
TABLES
to help you select the proper alloy for your casting specs



DURALOY

DURASPUN

*from pages 6 and 7 of our new General Catalog. No. 3354-G

— and there's lots more useful information about high alloy castings in our up-to-date catalog describing Duraloy Service. SEND FOR YOUR COPY.

As one of the pioneers in both static (1922) and centrifugal (1931) high alloy castings, we have a wealth of experience to focus on your high alloy casting problem. Send for our catalog, study it, and then let us help you get the best alloying combination to solve your corrosion, high temperature and/or abrasion problem.

The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

Happenings . . .

tion of liquefied gases at refineries was 7.6 million gallons per day, 16 percent greater than in 1957. Demand for liquefied gases for fuel and chemical uses in December was 30.1 million gallons per day, 15 million greater than in 1957. Liquefied-gas stocks hit 728 million gallons at the end of December. Production of natural gas liquids in 1958 averaged 33.4 million gallons per day. Demand for natural gas liquids for use in gasoline in 1958 was seven percent below 1957.

Water-Oil Fuel Feasible Reports U.S.S.R. Paper

The Soviet newspaper *Izvestia* reports that successful experiments have been made in the use of water and heavy oil emulsion as fuel for a river boat fleet at Astrakhan and for locomotives on the Moscow-Ryazan line. The paper said "high ranking Soviet scientists have recommended use of the fuel for power plants, river boats and locomotives," adding that the use of emulsion involves "simple reconstruction." The emulsion reportedly is formed with the use of compressed air to produce globules of water encased in oil "skins." When heat is applied, the water evaporates and bursts the "skin," and the oil fires immediately. Fuel used in the river boats contained 15-20 percent water and was one to three percent more efficient than normal oil fuels, the paper said. Mixtures containing 50 percent water were said to show "good results," but normal performance was equalled with 30-35 percent water emulsion. In tests with locomotives, the scientists found mixtures containing 30 percent water "did not diminish speed or traction power of the engine.

Coal Research Agency Is Requested by NCA

"Congress should establish an independent coal research and development agency to keep the coal industry fit to meet the demands of national emergency," according to the National Coal Association. Tom Pickett, NCA executive vice president, said present bituminous-coal research efforts "are not adequate to assure the future of the industry." Picketts' statement was prepared for the House Mines and Mining subcommittee, which is holding hearings on coal research legislation.

IPPA Seeks Investigation Of Rumanian Imports

Independent Petroleum Association of America has asked the Treasury Department to investigate importation of 90,000 barrels of Rumanian residual fuel oil unloaded in New York February 24, and an earlier shipment of Rumanian crude tar. In a letter to Treasury Secretary Robert Anderson, IPPA general counsel Russell B. Brown said, "we are confident that you recognize the impact such imports could have on the domestic petroleum

Photo taken at Delaware Refinery, Tidewater Oil Company

They keep the big cats roaring

The healthy roar of production from the big cat crackers is the measure of progress in refining and chemical technology. Teamwork between refiners and Cyanamid chemists helped to bring the development of one of the first synthetic fluid cracking catalysts and the first fully regenerative platinum reforming catalyst. Behind Cyanamid's service as a major catalyst producer are its unlimited resources as a major chemical producer.

Only Cyanamid's man with the golden rule can bring such vast chemical research and development facilities to the service of further refining progress.

Basic in Catalyst Chemistry

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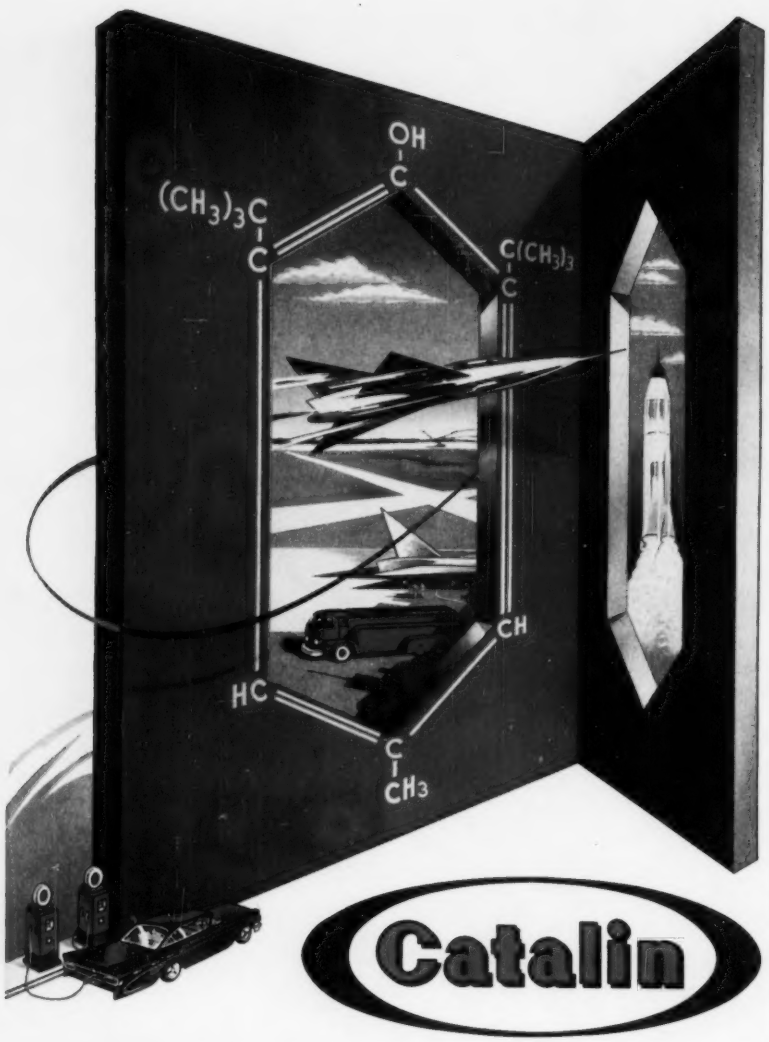
Originators of AEROCAT® Fluid Cracking Catalysts, AEROCAT TRIPLE A® High Alumina Catalysts, AEROCAT® 2000 Fluid Cracking Catalyst, AEROFORM® Fluid Hydroforming and Platinum Reforming Catalysts, AERO® HDS Catalysts, AERO® Specialty Catalysts, CYPAN® Drilling Mud Conditioner, AEROLUBE® Lubricating Oil Additives, AERONOX® Antioxidants, AEROSOL® Surface Active Agents.



Catalin

antioxidant CAO-1

98.9% PURE* / sets the highest standards for purity and effectiveness

Catalin ANTIOXIDANT CAO-1 . . . the field's finest grade of 2,6-ditertiary-butyl-para-cresol . . . meets U. S. Government military specifications for use in aviation gasolines, turbine and jet fuels. A major advantage achieved with this heat-resistant, water-insoluble antioxidant is that high-octane fuels are effectively protected, with no loss of octane rating. Gum and peroxide formations are inhibited, and deposits in the aircraft intake manifold and engine are markedly reduced.

Catalin ANTIOXIDANT CAO-1 stabilizes high-octane automotive gasolines, as well as turbine, insulating, hydraulic and transformer oils . . . in fact, nearly any petroleum hydrocarbon exposed to oxidizing conditions.

Samples, literature and technical assistance wait upon your request. Inquiries invited.

Catalin Corporation of America
One Park Avenue, New York 16, N. Y.

chemicals plastics resins

* *Typical Analysis*

Happenings . . .

industry and our national security . . . We respectively request that your department make the necessary inquiries to determine if there is any unfair competitive practice involved in these or any future petroleum imports from behind the Iron Curtain." If unfair practices are involved, action could be taken again Rumania under existing trade laws, says IPPA.

New Tax Bill Offered to Encourage Basic Research

Tax breaks to spur basic research in science are the subject of a bill introduced by Rep. Thomas Curtis (R-Mo.). Allowances would be granted industry and private donations. For industry, the measure would allow credit against taxable income up to 75 percent of the contribution, not to exceed three percent of the total taxable income. The bill allows industry double deduction for research expenditures, once as a tax credit and once for business expense. "This approach would keep Federal interference in research activities to a minimum," says Curtis. The bill provides for a board of leading scientists who would certify tax-exempt research projects.

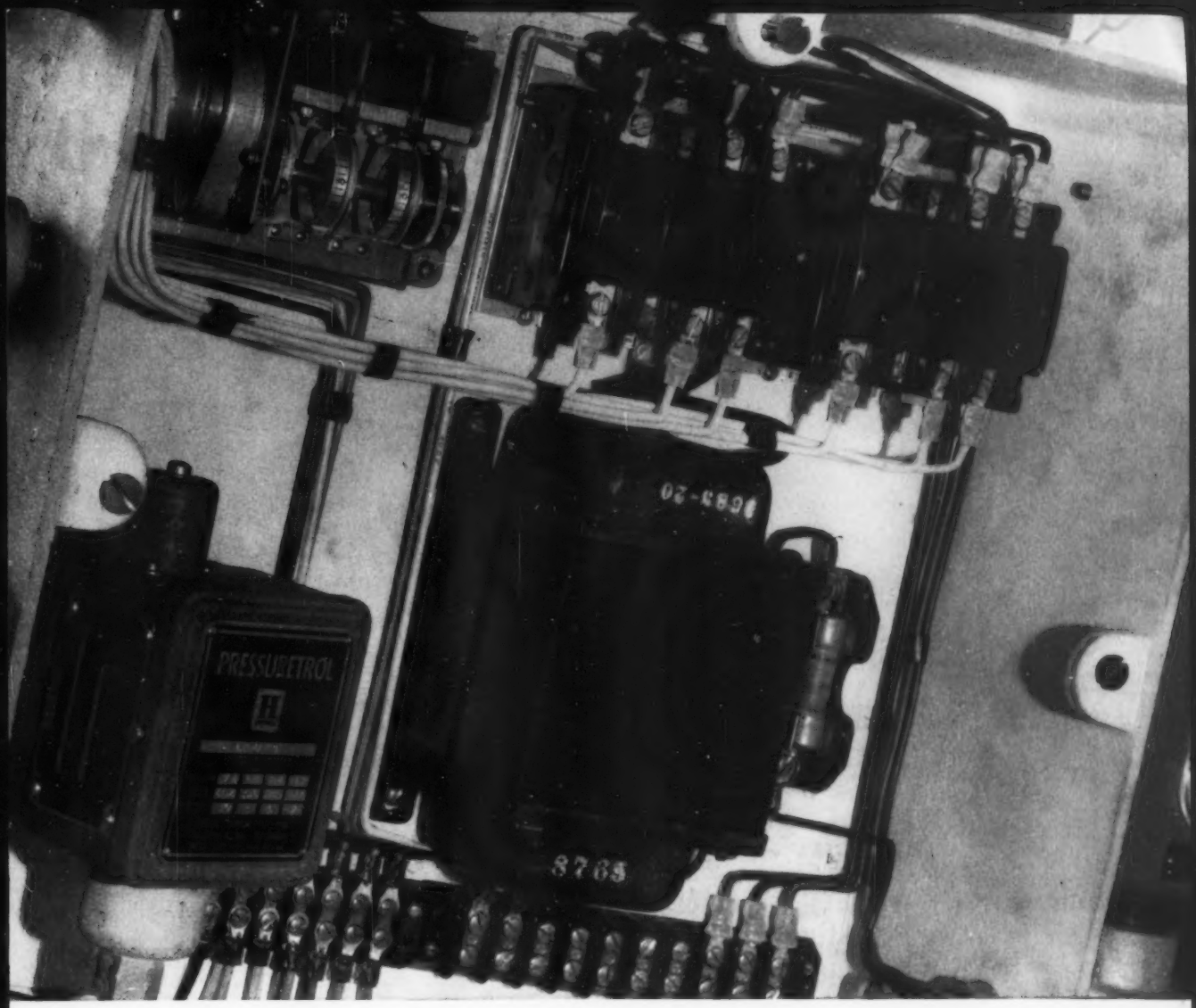
Gas To Be More Worry Than Oil, Says FPC Aide

"Imports of natural gas, especially liquefied methane, will eventually be a larger problem for the United States than current difficulties over oil imports," predicts Vice Chairman William R. Connole, Federal Power Commission. In citing the recent tanker shipment of methane to England, he said this new method creates a "new branch of the petroleum industry," bringing with it international natural-gas competition. Connole added that the physical problems of re-gasification and transportation of methane are being solved by engineers, but resultant political problems will be more complex than the present oil imports controversy. He added that the United States may have to use a body similar to the Cabinet Committee on oil imports to consider gas competition.

Aid Sought By Pemex, Gearing For Demand Hike

Petroleos Mexicanos, in anticipation of an annual 8-12 percent increase in oil demand, will welcome foreign technicians and drilling contractors, says Pascual Gutierrez Roldan, director general. The head of Mexico's nationalized industry reported that the country had reached a 300,000-bpd level of crude production and expects to hit 325,000 bpd toward the end of 1959. Some 470 wells will be needed to reach this goal, said Gutierrez. He added that Pemex plans several petrochemical plants, built with the aid of U.S. capital and engineers.

For more data on advertised products, use Readers' Service Cards, last page.



For "set it and forget it" gas drying—

Come to Kemp

Kemp Dryer protects instrument lines at −25° for Quaker State's Farmer's Valley, Pa. plant. Fully automatic operation saves time and manpower, yet provides dependable service on a 24 hour basis.

Here's the nerve center of every Kemp Fully Automatic Gas Drying Unit. Drying process gasses and inerts . . . air for pneumatic instruments and tools . . . liquids . . . for pressurizing anhydrous liquids . . . this panel controls the Kemp Dryer surely and safely. Once timed to meet your program, it provides efficient drying on a continuous basis, without worry or excessive maintenance.

Note the precision with which even the wiring is connected. It's typical of the thorough workmanship going into every component of the Kemp Dryer. Kemp Dryers are built with care; built to last and perform year after year with dependability resulting from a quarter century's experience.

Whether your operation calls for a completely automatic Kemp Dryer, a semi-automatic model, or a simple, manually operated unit, there's a model and capacity to meet your needs. Kemp Field Engineers will gladly study your problem and make complete recommendations, even down to the proper desiccant (we select from over 20) to do your job best.

Call in your Kemp Representative when you plan a new installation or wish to up-date an old one. He'll give you full information. Or write direct and ask for Bulletin D-102: THE C. M. KEMP MFG. CO., 405 E. Oliver Street, Baltimore 2, Maryland.

Convection Dryers

Inert Gas Generators

KEMP OF BALTIMORE

Nitrogen Generators

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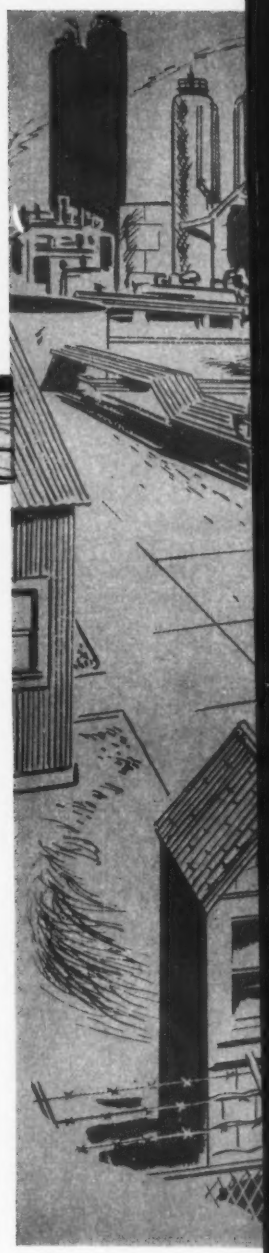

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For more data on advertised products, use Readers' Service Cards, last page.

Simplicity in steam traps can effect big savings in parts inventory and maintenance time

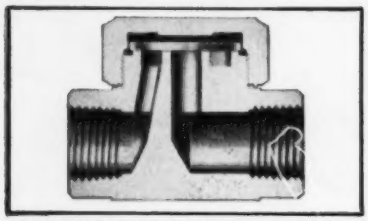
by John W. Ritter, Test Engineer
SARCO Company, Inc.

The function of all steam traps is to release condensate and prevent steam loss. However, the method of trapping can make a great difference in cost and effectiveness.

In the Sarco Thermo-Dynamic Steam Trap, the method is fundamental. Air or condensate entering the trap must flow from the inlet tube, radially across the underside of the disc valve, to the outlet. The space between the inlet tube and the disc forms a nozzle in which the static pressure energy of the incoming fluid is partly changed to velocity across the underside of the disc, with a resultant *decrease* in pressure. (This will be recognized, of course, as the Bernoulli Principle.) Use of this fundamental method means reliability in operation.

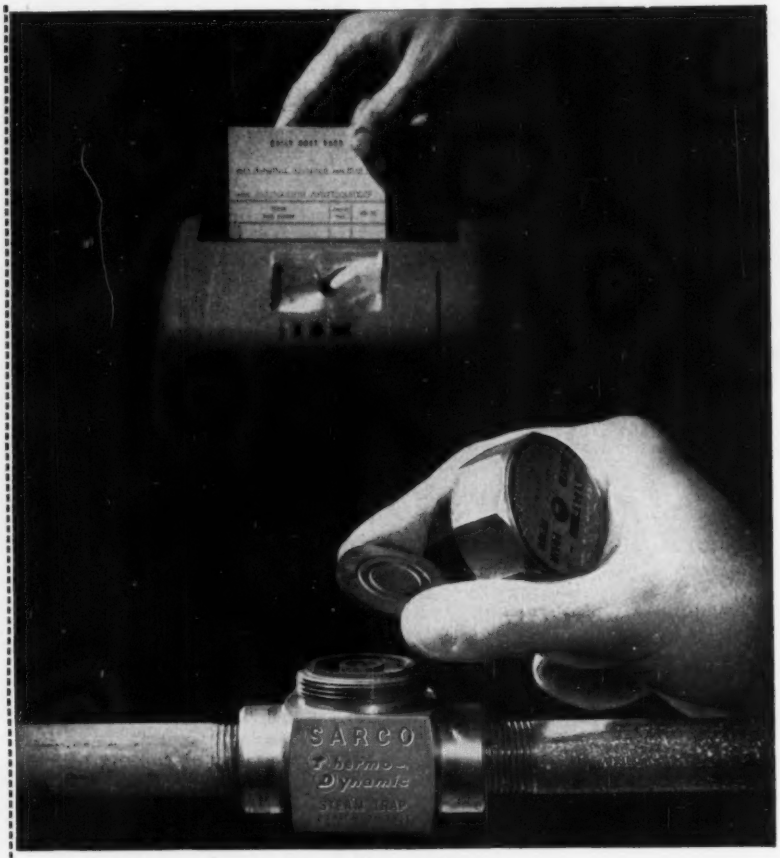
As the high velocity fluid jet strikes the side of the upper chamber, some recompression takes place, so that the pressure above the disc becomes greater than the pressure below it. The pressure reduction under the disc and the pressure recovery above it depend on the internal energy of the fluid. As the condensate above nearly approaches steam temperature, its internal energy is enough to overcome the upward force at the inlet tube and the disc snaps down in the inlet tube, which is the inlet valve seat.

Simultaneously, the disc also seals the outer ring, which isolates the space above the disc from the outlet. The disc valve is therefore held firmly against the inlet valve seat until the pressure in the control chamber is reduced by condensation. The upward force then exceeds the downward force and the disc valve opens.



This 3-part Sarco TD Steam Trap has only one moving part—the hardened, polished stainless steel disc.

No other trap uses the velocity of the fluid to operate the valve or uses the recompression of the flowing fluid to trap the valve closed and to hold it closed. When it closes, it closes tightly – no "operating steam" leaks out.



40 seconds inspection time— that's all it takes for a SARCO TD Steam Trap

Just back off the cap of a Sarco TD. Lift out its single moving part, the stainless steel disc. Wipe it off, and drop it back. No adjustment is ever required, at any load or any pressure in its range – from 10 through 600 psi.

The TD operates in any position, won't blow steam at any load. Small as a tee fitting, it can be installed in tight places. Its versatility and reliability cut cost of big replacement inventory.

Write for "Literature Kit 2A" today and get latest bulletins on the TD Steam Trap and other Sarco steam traps. Remember that Sarco can give you impartial advice on *Production Planned steam trapping* because . . . 5605-B

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COMPANY, INC.
635 Madison Ave., New York 22, N. Y.

Only Sarco makes all 5 types:
Thermostatic • Liquid Expansion • Float Thermostatic
Thermo-Dynamic • Bucket

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES

New Uses For Fuel Oil Sought by Battelle

A research program for the improvement of present oil-burner equipment and development of new uses for fuel oil has been started by Battelle Memorial Institute, Columbus, Ohio, under contract to API. The one-year project will be supervised by API's Marketing division. The Institute's President Porter said the project represents industry's growing concern over the position of fuel oil burners in the market for home heating units. The project's objective will be to seek new and better oil burner equipment and coordinate research. The project will (1) survey current research activities, (2) seek new concepts in fuel-oil combustion and evaluate ideas for use in residential burners, (3) use technical sources of oil companies (4) open communications among segments of the oil heating industry engaged in research.

Coal-Fired Gas Turbine Loaned for Research

A large $1-million coal-fired gas turbine, developed through 12 years of research, has been loaned to the Bureau of Mines by Bituminous Coal Research's Locomotive Development committee for studies "aimed at broader use of America's coal reserves." The 4,200 horsepower unit will be used in co-operative research with industry to ascertain changes needed to qualify this kind of equipment for use in stationary electric power plants. Another possible use is in generating of power in arid Western regions, as the coal-fired heater requires no water.

New Gas Has Anti-Smog Feature Says Tidewater

A new premium grade gasoline made by Tidewater Oil Co. will "cut the air pollution caused by automobile engines," according to the company. Tidewater says air pollution could be reduced from five to ten percent if all refiners adopted the new refining method, while admitting the new formula won't solve Los Angeles' smog problem. The method reportedly results in the boil-off of lighter ends. It involves a blending process that removes greater quantities of di-cyclic aromatics through desulfurizing, re-reforming, and redistilling.

Problems For IOCC Bill May Be In the Making

The Justice Department reportedly plans to complete its annual report on operation of the Interstate Oil Compact Commission before Congress adjourns, although it has a September deadline. This has caused speculation that the report may be critical of some aspects of IOCC. Legislation has been introduced in both Houses to extend IOCC another four years, through September, 1963.

- *Changing Times* -

Shell Oil Co. has developed a **"new super-tough, plastic and asphalt concrete paving. It combines** petroleum-derived **epoxy resin and asphalt** to make "indestructible" concrete.

Standard Oil Co. (N. J.) predicts that **business rise experienced by company in last half of 1958 will continue in '59.** Board chairman Eugene Holman foresees "a rise in general business activity resulting in **new high for U.S. petroleum demand."**

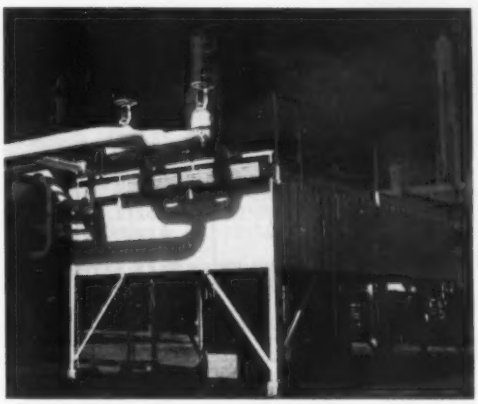
Solar Nitrogen Chemicals, Inc. has been formed by The Standard Oil Co. (Ohio) and Atlas Powder Co. **to manufacture and sell agricultural and industrial chemicals.** New firm will acquire all Sohio ammonia and petrochemical facilities at Lima, Ohio.

AviSun Corp. has been formed by American Viscose Corp. and Sun Oil Co. **to produce polypropylene.** Company says AviSun will be **"nation's largest commercial supplier of the material by mid-Summer".**

Sun Oil Co., Philadelphia, is planning **new automation system to be "free from preconceptions of the art of process control computing"** for its number 12 plant, Marcus Hook, Pa. **Genesys Corp. will take part** in joint development and investigative venture.

A $20,000 grant has been awarded to Case Institute of Technology by National Science Foundation. Money will finance experimental Summer conference **to teach 30 professors of chemical engineering** theory and techniques of **process control dynamics.**

Hi Fi SET?



Yes, SMITHCO Air Cooled Heat Exchangers DO have Hi Fidelity — they are engineered to provide faithful service long after others have ceased to operate.

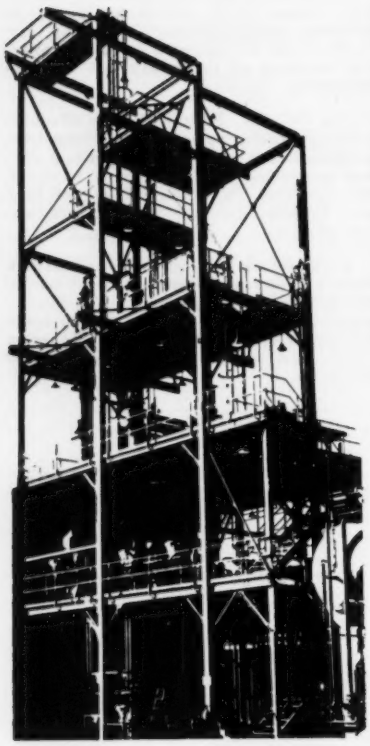
A SMITHCO Heat Exchanger compares in other ways with a precision built Hi Fi set. For example, you wouldn't buy a Hi Fi in which all electrical connections were merely wrapped instead of one with conventional soldered connections, would you? Well, then, it follows that you wouldn't buy a heat exchanger with the fins wrapped instead of soldered to the tube.

SMITHCO is the ONLY major manufacturer of air cooled heat exchangers with solder bonded fin tubes. This solder bond assures the highest efficiency of heat transfer between fin and tube and has proven to be the most permanent bond yet devised.

See SMITHCO Air Cooled Heat Exchangers in action at the IPE.

SMITHCO
ENGINEERING INC

P O BOX 3217 PHONE GI 7-5545 TULSA, OKLAHOMA



Measure process stream impurities

AS LOW AS 0.01%

with L&N's Chromomax® gas Chromatography analyzer

Give your plant operators a realistic picture of your process streams . . . detect component concentration as low as 0.01% . . . and boost product quality.

If your process streams contain natural gases, vapors or low boiling point liquids, you can analyze up to four streams with a single Chromomax Analyzer . . . and it can handle as many as eight components per stream.

More versatile than ever, this Analyzer has a host of features that assure you of getting the analysis you want — in the form you want — even if your process requires special sampling techniques, electronic integration, dual column switching, column back-flushing, or stream identification.

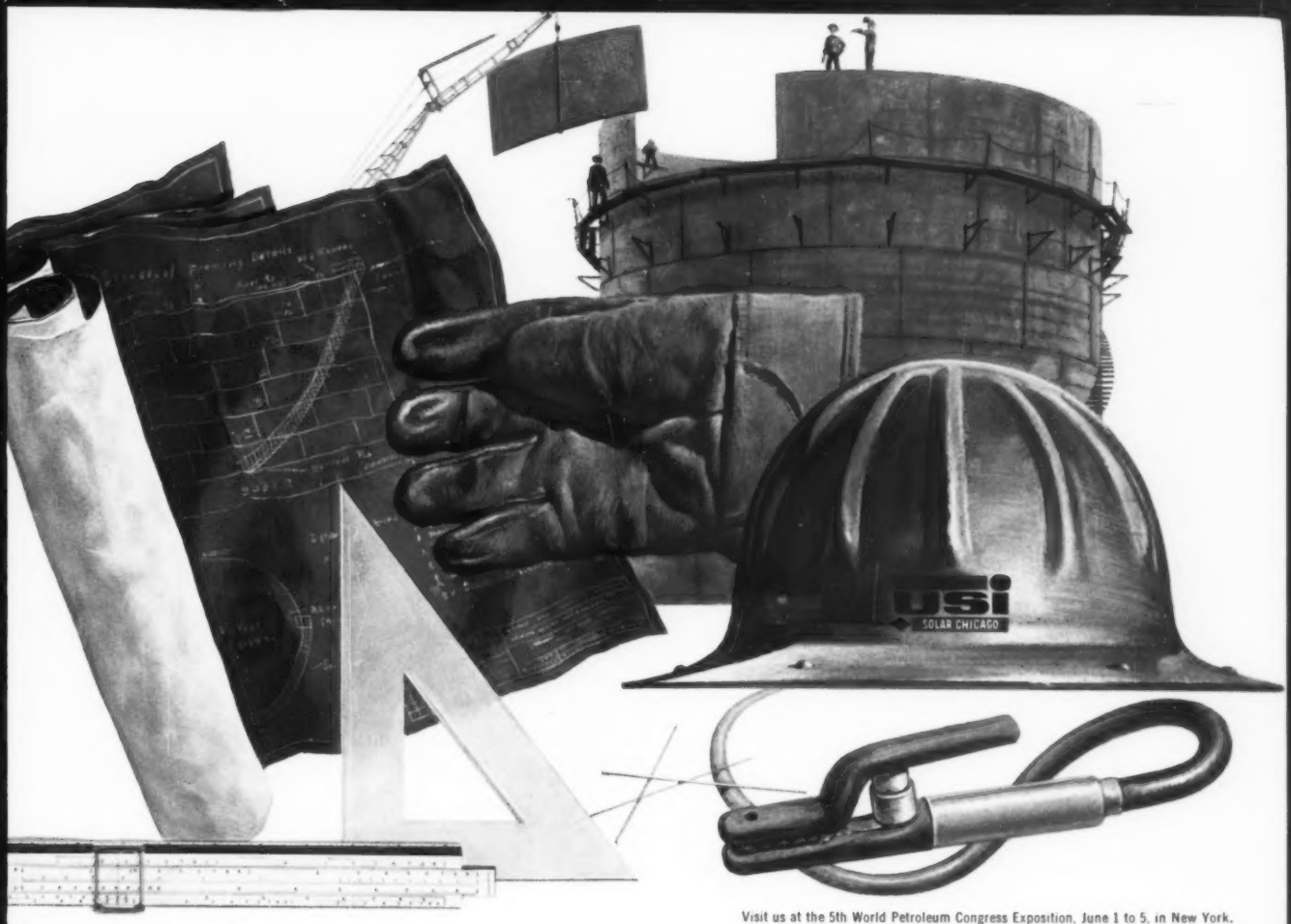
Write now for information from Leeds & Northrup Co., 4923 Stenton Ave., Philadelphia 44, Pa.

LEEDS NORTHRUP
Instruments Automatic Controls • Furnaces

Meetings Calendar

Apr.	
19–23	**American Society of Mechanical Engineers,** Oil and Gas Power Conference and Exhibit, Shamrock Hilton, Houston.
20–22	**American Oil Chemists' Society,** Spring Meeting, Roosevelt Hotel, New Orleans.
21–23	**American Society of Lubrication Engineers,** Annual Meeting and Exhibit, Hotel Statler, Buffalo, N.Y.
22–24	**Natural Gasoline Association of America,** Annual Convention, Baker and Adolphus Hotels, Dallas.
23–24	**ASME,** and Society of Apparatus Manufacturers, Management Conference, Statler-Hilton Hotel, New York.
29–30	**Western Petroleum Refiners Association,** Southwest Regional Technical-Industrial Relations Meeting, Hotel Paso del Norte, El Paso.
May	
1–	**American Institute of Chemical Engineers,** St. Louis Section, Coronado Hotel, St. Louis.
3– 6	**Liquefied Petroleum Gas Association,** Annual Meeting, Conrad Hilton Hotel, Chicago.
4– 5	**ASME,** Maintenance and Plant Engineering Division Conference, Edgewater Beach Hotel, Chicago.
4– 8	**American Petroleum Institute,** Safety and Fire Protection Committees, 12th Midyear Meeting, Rice Hotel, Houston.
5– 7	**Annual Industrial Waste Conference,** Purdue Memorial Union Building, Lafayette, Ind.
7– 9	**Petroleum Industry Electric Association,** Petroleum Electric Supply Association, Joint Meeting, Moody Center, Galveston, Texas.
7–	**Armour Research Foundation,** Symposium on Corrosion Inhibitors, Theory and Mechanism, Illinois Institute of Technology, Chicago.
10–12	**Industrial Mutual Aid and Disaster Control** Conference, Baton Rouge, La.
10–13	**AIChE,** National Meeting, Kansas City, Mo.
11–13	**American Institute of Electrical Engineers,** Conference on Automatic Techniques, Chicago.
14–16	**American Institute of Industrial Engineers,** National Industrial Engineering Conference and Conference and Convention, Biltmore Hotel, Atlanta.
14–23	**International Petroleum Exposition,** Tulsa.
18–20	**ISA,** 5th Annual Symposium on Instrumental Methods of Analysis, Shamrock Hilton Hotel, Houston.
25–27	**American Society of Quality Control,** Industry Production and Quality Control Exposition, Cleveland.
25–28	**ASME,** Design Engineering Conference, Convention Hall, Philadelphia.
27–29	**Annual Short Course in Gas Technology,** Texas College of Arts and Industries, Kingsville, Texas.
27–30	**API,** Division of Refining, Midyear Meeting, New York.
30-Jun 5	**Fifth World Petroleum Congress Exposition,** New York Coliseum, New York.
31-Jun 5	**Industrial Research Conference,** Arden House, Harriman Campus, Columbia University.
June	
8– 9	**Industrial Water Conservation Course,** University of Michigan.
8–12	**Technical Writer's Institute,** Rensselaer Polytechnic Institute, Troy, N.Y.
10–12	**ISA,** International Symposium on Gas Chromatography, East Lansing, Mich.
14–19	**Society of Automotive Engineers,** Summer Meeting, Chalfonte-Haddon Hotel, Atlantic City.
17–18	**ASME,** Engineering Management Conference, Statler Hilton Hotel, Los Angeles.
21–26	**American Society for Testing Materials,** Annual Meeting Chalfonte-Hadden Hall, Atlantic City.
22–26	**National Association of Corrosion Engineers,** Corrosion Control and Reaction Intermediate Level Short Course, Massachusetts Institute of Technology.
24–25	**WPRA,** Mid-Continent Technical-Industrial Relations Meeting, Broadview Hotel, Wichita.
29–July 3	**Gordon Research Conferences,** Catalysis, Colby Junior College, New London, N.H.
Aug.	
10–13	**Society of Automotive Engineers,** National West Coast Meeting, Hotel Georgia, Vancouver, B.C.
Sept.	
9–10	**ASME,** International Congress on Air Pollution, New York.
13–18	**ACS,** 136th National Meeting, Atlantic City.
17–	**NGAA,** Rocky Mountain Regional Meeting, Casper or Calgary, Alberta.
20–23	**ASME,** Petroleum Mechanical Engineering Conference, Rice Hotel, Houston.
21–25	**ISA,** Annual Instrumentation-Automation Conference and Exhibit, International Amphitheater, Chicago.
23–24	**WPRA,** Rocky Mountain Technical-Industrial Relations Meeting, Henning Hotel, Casper.

For more data on advertised products, use Readers' Service Cards, last page.



Visit us at the 5th World Petroleum Congress Exposition, June 1 to 5, in New York.
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Have Crews...will travel

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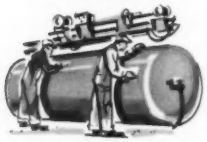

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FIELD ERECTION

What you need in field erection... When you need it...Where you need it

Our field crews at Solar Chicago are craftsmen capable of handling the erection and construction of pressure vessels, towers, tanks, shells or other structures. These men have stacked up years of experience and have been organized into highly efficient mobile crews ready to tackle the toughest job. They find it no problem to translate your needs into the structure you require on your site, on time.

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P. O. Box 101
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Solar Chicago
274 Madison Avenue
Murray Hill 7-9298

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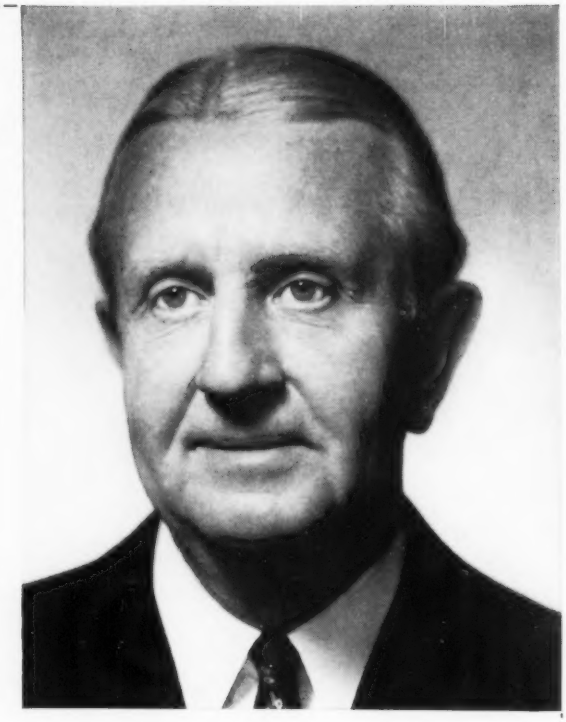

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New Books...

Thermodynamics Text

"Introduction to Chemical Engineering Thermodynamics," second edition, is an easily understood treatment of thermodynamic principles and their major applications in chemical engineering. It includes a study of the first and second laws of thermodynamics and carries through with applications of both laws to fluid dynamics, power generation, refrigeration, phase and chemical equilibria, and other related subjects. Particular attention is given to basic subjects.

(Smith, J. M., and Van Ness, H. C., *Introduction to Chemical Engineering Thermodynamics.* Second Edition McGraw-Hill Publishing Co., 330 West 42nd Street, New York 36, N. Y. 490 pages, $8.75. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

Petroleum Products Tests

"ASTM Standards on Petroleum Products and Lubricants," latest edition, brings together in convenient form the various ASTM standard and tentative methods of test and specifications pertaining to petroleum products and lubricants.

(ASTM, *ASTM Standards on Petroleum Products and Lubricants,* American Society for Testing Materials, 1916 Reace St., Philadelphia 3, Pa., 1,214 pages, $6.60.)

New Corporate Diagrams

"Corporate Diagrams and Administrative Personnel of the Chemical Industry," 1959 edition, brings up-to-date the diagrams and personnel from the 1958 edition (reviewed, page 242, PETROLEUM REFINER, May, 1958) and contains many new organizational charts. Among new entries are Celanese's Chemical division, W. R. Grace's Chemical group, Lithium Corp., Neville Chemical, Merck, American Viscose and others. Included is a supplement to the issue which will be sent all subscribers in September.

(Kern, Kenneth R., *Chemical Economic Services,* 15 Chambers St., Princeton, N. J., 77 pages, $20.00.)

Oil Industry Accounting

"Accounting Practices in the Petroleum Industry" is a complete and authoritative guide to accounting methods encountered in every phase of the oil industry. All basic operations, from leasing prospective producing properties to refining processes, transportation, and marketing the end products, are succinctly described. Reasons for practices followed are given at each stage so they are easy to follow. The book has a full glossary of petroleum industry terms and procedures.

(Irving, R. H., and Draper, V. R., C.P.A.'s, *Accounting Practices in the Petroleum Industry,* The Ronald Press Co., New York 10, N. Y., 247 pages, $6.00. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.).

Work Measurement Text

"Work Measurement" presents essential information on all phases of a work measurement program—why work is measured, what it means to company personnel, the standard data approach, economics of work measurement, the consultant's role, work standards "don'ts," and labor relations and work measurement.

(Rotroff, Virgil H., *Work Measurement,* Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y., 203 pages, $4.85.)

Electrical Installations

"API Recommended Practice for Electrical Installations in Petroleum Refineries" (RP 540), first edition, has been published. It presents practices generally accepted in the petroleum industry, important features of electrical systems based on generally acceptable electrical design, and installation practices which experience has shown result in safe, reliable, efficient, and economical operation of refinery equipment.

(API, *Recommended Practice for Electrical Installations in Petroleum Refineries, (RP 540),* Publications department, American Petroleum Institute, 50 W. 50th St., New York 20, N. Y., $2.00.)

ASTM Standards for 1958

"The Book of ASTM Standards," 1958 is being published in 10 parts. Each one is made available as rapidly as editorial, press work and binding will permit. Each has a detailed subject index and list of standards in numeric sequence. To keep this book up to date, supplements will be issued to each part late in 1959 and 1960. A complete index is furnished without charge with each set. Parts included are (1) Ferrous Metals Specifications, $12.00, (2) Non-Ferrous Metals Specifications, Electronic Materials, $10.00, (3) Methods for test for metals, $10.00, (4) Cement, Concrete, Mortars, Road Materials, Waterproofing, Soils, $12.00, (5) Masonry Products, Ceramics, Thermal Insulation, Sandwich and Building Constructions, Acoustical Materials, Fire Tests, $12.00, (6) Wood, Paper, Adhesives, Shipping Containers, Cellulose, Leather, $10.00, (7) Petroleum Products, Lubricants, Tank Measurements, Engine Tests, $12.00, (8) Paint, Naval Stores, Aromatic Hydrocarbons, Coal, Coke, Gaseous Fuels, Engine Antifreezes, $12.00, (9) Plastics, Electrical Insulation, Rubber, Carbon Black, $14.00, and (10) Textiles, Soap, Water, Atmospheric Analysis, Wax Polishes, $12.00.

(ASTM, *The Book of ASTM Standards, 1958,* American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., $116.00 per set.)

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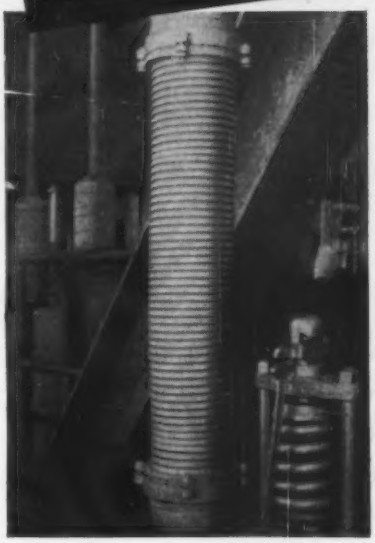
• PREVENTS BREAKS



PENFLEX TUBING ABSORBS THERMAL EXPANSION SHOCKS

Thermal expansion 900°F . . . pressures up to 850 psi. . . . . impact and pipe movement under terrific strain, but Penflex safely handles them all. That's the story of Penflex 8" I.D. stainless steel interlocked tubing welded into the pipeline, eliminating the cost of flanging the joint as well as the pipe. This was installed as an expansion joint on safety blow-off valves.

Wherever thermal expansion, pressures and shock are factors in keeping steam, air, water or chemical lines from breaking you can rely on Penflex Interlocked Tubing and Penflexweld High Pressure Tubing. Available in steel, bronze and stainless steel from ⅛" I.D. to 24" I.D. Write for complete details to Pennsylvania Flexible Metallic Tubing Company, Inc., 7207 Powers Lane, Philadelphia 42, Pa.

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TIGHT AS A PIPE BUT...

FLEXIBLE

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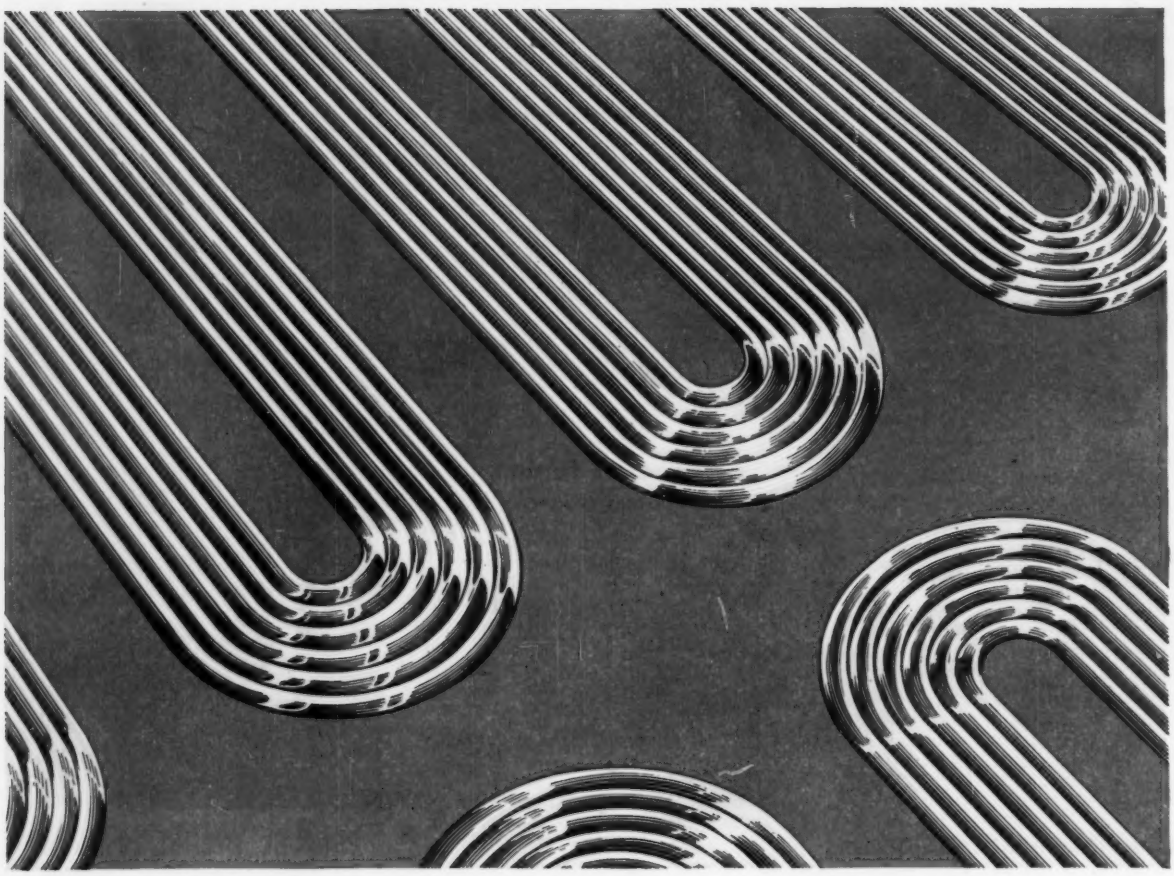

NOW! U-BEND HEAT EXCHANGER TUBES BY CHASE

save time, trouble, money . . . all these ways!

SAVE on installation costs by eliminating one tube sheet . . . halving welding or rolling-in operations.

SAVE because handling is minimized.

SAVE time, labor and equipment used to fabricate U-bend tube on the job site.

SAVE because U-bend eliminates need for floating heads by handling differential expansions.

SAVE by eliminating scrap. Tubes fabricated to specifications do away with waste-end scrap.

SAVE because pallet loading insures storage economy.

Now you can order *pre-fabricated* tubes from Chase. That means you can realize the many on-the-job advantages of U-Bend tube, and at the same time be sure of *quality*.

Chase tube is manufactured under constant production control. Relief annealing immediately after bending avoids possible stress-failure later; precision hydrostatic testing of bends detects any possible hidden defects.

Chase U-Bend tube is available in uniform gauge, as well as with thickened center. Sizes range from ⅝" o.d. to 1" o.d., bent on radii from ⅞" to 25" depending on your requirements.

When ordering, be sure to include the following information: O.D. and I.D. in inches; wall thickness; length; quantity; alloy or material; temper; bend radius; length of thickened portion on dual-gauge tubes. Talk your specific needs over today with your nearest Chase office, or write Chase at Waterbury 20, Connecticut.

Chase®

BRASS & COPPER CO., WATERBURY 20, CONN.

Subsidiary of ***Kennecott Copper Corporation***

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY BRASS & COPPER

THE NATION'S HEADQUARTERS FOR ALUMINUM • BRASS • BRONZE • COPPER • STAINLESS STEEL

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Men In Industry...

Argue

Hartridge

Fred W. Argue, engineering manager and vice president of Stone & Webster Engineering Corp., has been named executive vice president. As senior officer in the Boston office he will be responsible for executive coordination of corporation activities there. **Alfred L. Hartridge,** treasurer and a vice president, was elected financial vice president, New York, where he will coordinate financial activities of domestic and foreign subsidiaries.

Harold S. Skinner, associate general counsel for Continental Oil Co., has been named assistant to the president and director of public affairs. He joined the company as an attorney at Ponca City, Okla., in 1948, and was promoted to general attorney for the Central region, Oklahoma City, in 1951. He became assistant general manager of the Central region in 1952, and later that year transferred to Fort Worth as assistant general manager of the Southwestern region. Skinner was named assistant to the president in 1954, and in 1956 was promoted to associate general counsel.

Skinner

C. B. Branch has been named manager of The Dow Chemical Co.'s overseas and foreign activities except those in Canada and Mexico. He has also been named head of Dow Chemical International, Ltd., S.A.

J. H. Corbitt has joined Humble Oil & Refining Co.'s Technical division, Distillation section, Baytown, Texas. He has a B.S. degree in chemical engineering from Alabama Polytechnic Institute.

Martin A. McNulty retired recently from Standard Oil Co. (Ind.). With the company since 1916, he has been comptroller since 1945. McNulty will be succeeded by **William A. Underwood,** assistant comptroller.

Coleman J. Major, former head of high energy fuels and plant development, American Potash & Chemical Corp., has been named professor of chemical engineering at the State University of Iowa.

James E. Beavers has been named superintendent of Arkansas Fuel Corp.'s May gasoline plant going up near Kingsville, Texas. Other promotions: **Owen Jenkins,** superintendent, East Texas plant; **Clint W. Teller,** plant foreman, Panola plant and **Homer B. Brown,** field foreman and plant operations assistant, East Texas plant.

John H. Beckwith has been named head of the Operations Research section, Esso Research and Engineering Co., Planning Engineering division. He has been with the company since 1951.

F. Pierce Coggeshall, Jr., has been named assistant manager of the Asphalt department, American Oil Co. He has been with the company since 1951.

A. P. McGuire has been named plant manager of American Chemical Corp.'s Watson, Calif., plant, which is under construction. He had been assistant plant manager at Stauffer Chemical Co.'s Louisville plant.

Edward D. Boston has been appointed assistant director of Esso Research and Engineering Co.'s Chemicals Research division. He formerly headed a section in the Chemicals Development division.

Gardiner Blackman has been named manager of Tidewater Oil Co.'s Employe Relations department, Los Angeles. He was previously employe relations supervisor, Western division.

R. J. Waugh has been appointed general manager, The Lummus Co., Canada, Ltd. He joined the company in London, England, as a process engineer in 1951, being engaged in plant design for refinery and chemical plants. He went to Canada in 1956 to join The DuPont Co., of Canada, and rejoined Lummus in 1958. Before joining Lummus, Waugh was in the RAFVR from 1943-1947.

Waugh

C. N. Sechrist has been named a group leader in American Oil Co.'s Research and Development department. Other promotions: **B. M. Drinkard,** senior chemist, group leader; **F. M. Jacobsen,** and **F. E. James, Jr.,** senior chemical engineers and group leaders; **R. L. Stack,** administrative supervisor, and **William Schoen,** senior chemist.

Dr. Aaron Wachter, director of research for Shell Development Corp., has received the 1958 Frank Newman Speller Award in recognition of his achievements in corrosion engineering.

Walter H. Stanton has been awarded an academic leave of absence from Monsanto Chemical Co. He will return to college this Fall to study the subject of his choice while receiving full pay and reimbursement for tuition, fees and books from Monsanto. Stanton was recently promoted from manager of engineering planning, Plastics division, to technologist.

Dr. O. N. Miller has been appointed to the board of directors, Standard Oil Co. of Calif. He received his Ph.D. degree in chemical engineering from the University of Michigan, joined Standard in 1934 and has held a number of positions in company research and refining operations.

T. J. Maitland, American Telephone & Telegraph Co., New York, has been named chairman of NACE's Technical Practices committee. He has been active in the association since 1944, and has written several papers presented at national conferences.

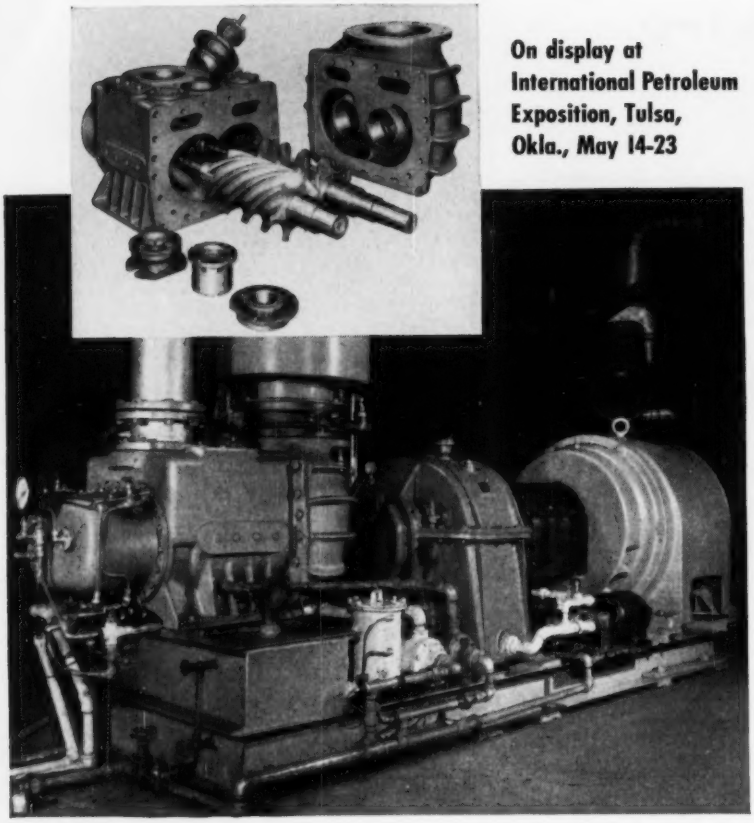
Charles E. Spahr has become chief executive officer of The Standard Oil Co. (Ohio) and **Clyde T. Foster** chairman of the board and director of public relations. Edward F. Morrill will be vice president, petrochemicals.

R. H. Ells II has joined the Technical division, Humble Oil & Refining Co., Houston, as have **W. C. Robinson, Jr.,** and **L. C. Smith.** Ells and Robinson hold B.S. degrees in chemical engineering from Louisiana State University and The University of Texas, respectively. Smith has a B.S. degree in mechanical engineering from the University of Oklahoma.

David L. Matthews has been named manager of manufacturing of Goodrich-Gulf Chemicals, Inc., Cleveland. Previously chief engineer of the firm, he joined the company in 1955. Matthews has a B.S. degree in mechanical engineering from Iowa State College.

Charles O. Peyton has been named general manager of Esso Standard Oil Co.'s petroleum specialties department. He has been assistant general manager of Esso Standard's Petroleum Specialties department since last May, and was formerly head of the Technical division at Esso's Baton Rouge refinery. A chemical engineering graduate of Louisiana State University, he joined

Peyton



On display at International Petroleum Exposition, Tulsa, Okla., May 14-23

NEW *Fairbanks-Morse Positive Displacement Axial-Flow...*

Oil-Free Rotary Compressor

for pressure, vacuum or booster service!

Here is a mechanically-simple, precision-built, high-efficiency compressor that combines the best features of reciprocating and centrifugal designs!

The new Fairbanks-Morse Axial-Flow Rotary Compressor is a two-impeller helical-lobe type machine ...ideal for a wide variety of applications...smooth in performance, adaptable to any power source. Unit weights and space requirements are impressively low.

Standard models are available in single-stage units with capacities from 800 to 12,500 cfm. at compression ratios from 1.6:1 to 5.0:1—or in two-stage units with capacities from 2,000 to 12,500 cfm. at compression ratios above 5.0:1—and for booster service at maximum working pressures up to 250 psig.

Contact your nearby Fairbanks-Morse Branch, or write Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill.

Ask for new Bulletin ACO 100.1.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

COMPRESSORS · PUMPS · SCALES · DIESEL, DUAL FUEL AND GAS ENGINES
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Men . . .

Esso 17 years ago at Baton Rouge, and has been a divisional and departmental head.

Wilfred O. Taff has been named an associate director in Esso Research and Engineering Co.'s Research department. He has been with the company since 1939. **Donald L. Baeder** has been named assistant director in the division.

E. L. Crowe has been appointed controller of Fluor Products Co., responsible for accounting and budgeting. He was previously supervising auditor for the Atomic Energy Commission, Idaho operations office, Idaho Falls. He started with Fluor in the Internal Audit section in 1953. From 1954 to 1956 he was administrative manager on the Dhahran Air Base, Saudi, Arabia. He was then appointed auditor for The Fluor Corp., Ltd.

Crowe

Theodore Marks has been promoted to senior project engineer, Neches Butane Products Co., Port Neches, Texas. He will supervise certain plant technical operations. Prior to his present duties, Marks spent two years on design and construction of new facilities for butadiene production.

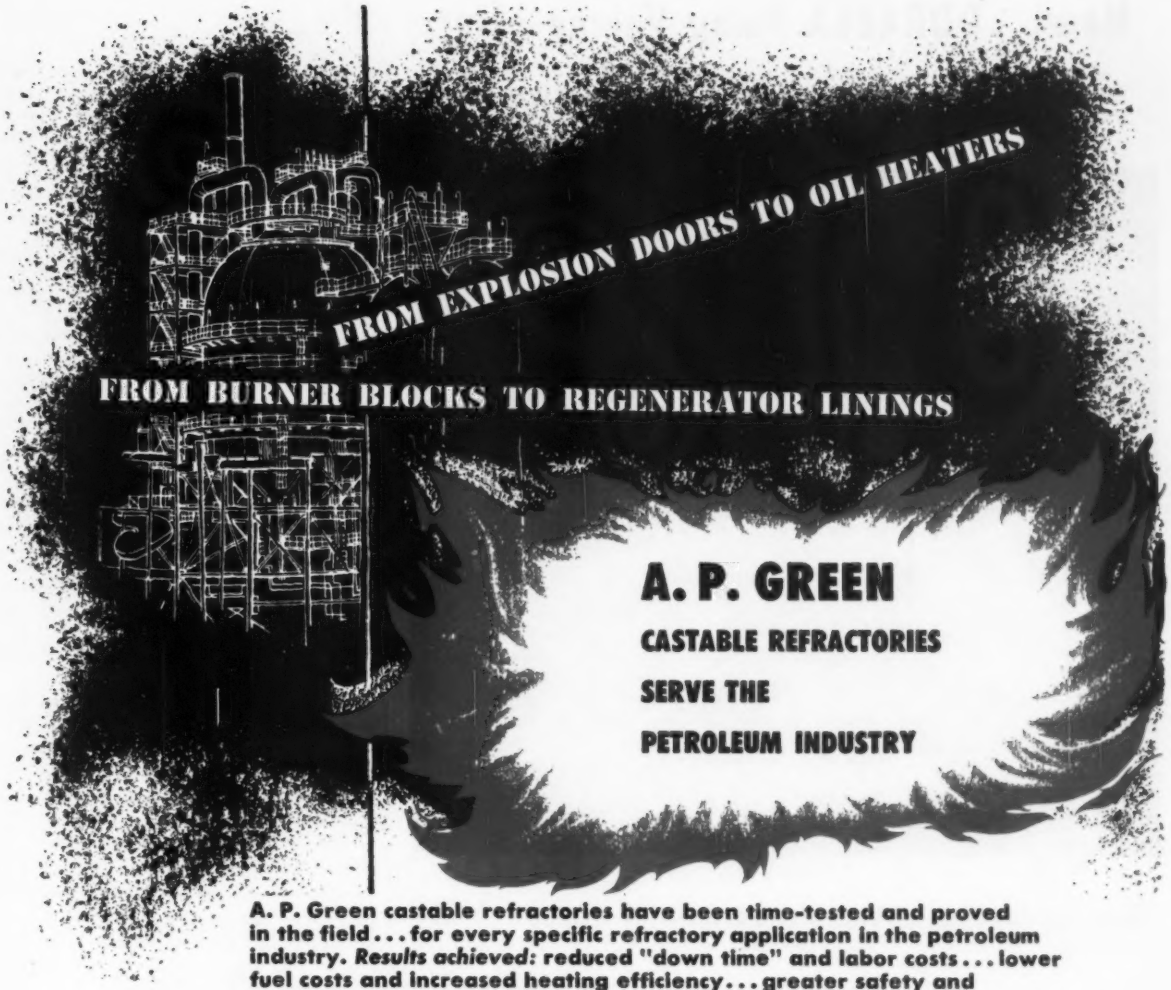
James A. Plumstead, Jr., has been named an engineering associate for Esso Research and Engineering Co., Linden, N. J. **William W. Bray, Jr.,** has been named head of the Petrochemicals section, Design Engineering division, and **Leonard Hollander** has been appointed head of the Design Engineering division's Equipment Development section.

William J. Carthaus, president of Great Northern Oil Co., St. Paul, Minn., has been elected president and chief executive officer of Western Petroleum Refiners Association. He has been with Shell Oil Co. and Deep Rock Oil Corp.

Dr. Thomas Aczel has joined Humble Oil & Refining Co.'s Research and Development division, Baytown, Texas. He has a Ph.D. degree in physical chemistry from University of Trieste, Italy.

Harry M. Hartzband has been named head of the Powerforming section, Esso Research and Engineering Co., Linden, N. J. Holder of B.S. and M.S. degrees in chemical engineering from Columbia University, he joined Esso Research in 1948.

Marc F. Braeckel, formerly director of marketing and executive vice-president of Sinclair Refining Co., has been elected chairman of the board. **Louis W.**



A. P. Green castable refractories have been time-tested and proved in the field . . . for every specific refractory application in the petroleum industry. *Results achieved:* reduced "down time" and labor costs . . . lower fuel costs and increased heating efficiency . . . greater safety and reduced maintenance control.

For detailed information and specific recommendations . . . write, Engineering Department, A. P. Green Fire Brick Company . . . or call your local A. P. Green distributor.

A. P. Green Castable Refractories . . . designed to exact specifications to do an exact job

KAST-SET — A rapid setting, high strength refractory castable. Mixed with water, it takes on a hydraulic bond without the application of heat. KAST-SET will not shrink, has excellent resistance to abrasion, and is ideally suited for monolithic linings. It may be used at temperatures up to 2700° F.

KAST-O-LITE — A lightweight castable recommended for temperatures up to 2500° F. It is used for monolithic linings in all types of stills and heaters, tar stills, heat treating furnaces, flues, and stacks. Reduces heat loss. Insures closer temperature distribution and control.

CASTABLE INSULATION NO. 20 — A hydraulic-setting castable for temperatures up to 2000° F. Recommended for complete monolithic linings and lightweight panel construction in oil stills and heaters. Weighs 50 pounds per cubic foot in place.

CASTABLE BLOCK MIX — A hydraulic-setting castable insulation for temperatures up to 1600° F. CASTABLE BLOCK MIX combines the advantages of a castable material with low conductivity and light weight. It provides maximum insulating efficiency and ease of installation. Weighs only 20 pounds per cubic foot in place.

CASTABLES FOR GUN APPLICATION . . . SK-7 — Gun application of SK-7 produces a lightweight lining with excellent strength and insulating efficiency for temperatures up to 1800° F. Installation and labor costs are reduced . . . no forms required. Ideal lining for ducts, flues and breechings.

KS-4 — This strong abrasion resistant castable can be gun applied with a minimum of rebound loss. Recommended for catalytic regenerator linings, stack linings, bubble towers, and duct linings exposed to abrasion or corrosion. For temperatures up to 2550° F.

A P Green REFRACTORY PRODUCTS

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Mexico, Missouri, U.S.A.

Plants: Mexico, Mo. — Woodbridge, N. J. — Sulphur Springs, Texas — Jackson, Oak Hill, South Webster, Ohio — Philadelphia, Pa. — Troy, Idaho — Pueblo, Colo. — Macon, Ga. — Climax, Pa.

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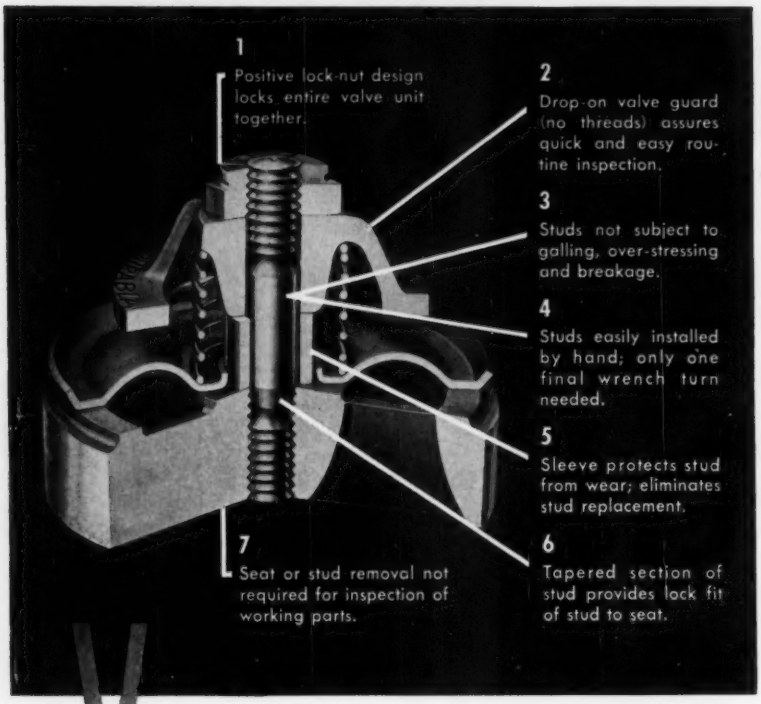
Now...DURABLA Pump Valves offer 7 new points of superiority!


1
Positive lock-nut design locks entire valve unit together.
2
Drop-on valve guard (no threads) assures quick and easy routine inspection.
3
Studs not subject to galling, over-stressing and breakage.
4
Studs easily installed by hand; only one final wrench turn needed.
5
Sleeve protects stud from wear; eliminates stud replacement.
6
Tapered section of stud provides lock fit of stud to seat.
7
Seat or stud removal not required for inspection of working parts.

New V-design assures even greater dependability

You want *maximum valve dependability* for your reciprocating pumps . . . and DURABLA gives you just that in the new V-7 unit.

Incorporating seven points of superiority, the new valve features a tapered or V-shaped stud which screws down tight to the seat. This exclusive design anchors the stud, eliminating any possibility of galling, over-stressing or breakage. What's more, the new self-locking nut and drop-on guard assure quick and easy inspection of working parts—without stud or seat removal.

Remember: In the DURABLA Valve, only "point contact" is made by the valve member on the stud sleeve, so it can't bind or hang-up. The open-type guard assures free flow of liquid, prevents clogging.

These stainless-steel valves operate freely under temperature extremes, with corrosives, and in any position. Made in 15 sizes to fit any reciprocating pump, old or new.

Send for *NEW* 8-page booklet PR-49.

Keep your pumps fit with the valves that fit all pumps.

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DM-26

DURABLA MANUFACTURING COMPANY

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Men . . .

Leath, formerly vice-president and general sales manager, Western region, has been elected vice-president of Sinclair Oil Corp. **Leo J. Hoar,** formerly vice-president and general sales manager, Eastern region, has been elected vice-president and director of marketing of Sinclair Refining.

Dayton H. Clewell, general manager of Socony Mobil Oil Co.'s Research department, will manage the company's new Central Research division. Other divisional appointments: **Guy R. M. del Giudice,** Applied Research and Development; **Theodore G. Roehner,** Technical Service and **Edward S. Nicholls,** Administration. **John W. Payne** will be senior scientist.

Dr. Karl Dittmer, former head of the Florida State University department of chemistry, has been named program administrator of the Petroleum Research Fund, administered by ACS. His office will be in the Society's national headquarters, Washington. A chemistry teacher for 13 years, Dr. Dittmer organized the graduate program for the Ph.D. degree in chemistry at Florida State.

Raymond Gibson, former Vickers Petroleum Co. senior process engineer, has been named manager of the company's Refinery Blending and Transfer section.

C. W. Lutz has been named director, Planning and Economics department, Gulf Oil Corp. He will be responsible for long range planning and will provide

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the registry.

Cyclobutane
5.5-Dimethylcyclopentadiene
Tetradecylmethyl ketone
1-Methylcyclobutene
1,1,1-Trichloro-2-propanol (Isopral)
p-Nitrobenzenediazonium p-toluene sulfonate
Propane-1,3-dithiol-2-carboxylic acid Chloramide
N,N'-Dimethyl-decahydro-2-naphthylamine
Perchlorocyclohexane
Perchlorocyclohexene
2,2'-Thiobis(4-chloro-6-methyl phenol)
N-(2-Naphthyl)phosphoramidic acid
Hexadecylmethyl ketone
3-Hydroxy-4-methoxycinnamic acid (Isoferulic acid)
2-Isocyanatopropane
β,β,β-Trichloroborazole
2,3'-Bipyridine
Pentachlorocyclopentadiene
3',3",5',5"-Tetrabromophenolphthalein ethyl ester, potassium salt

For more data on advertised products, use Readers' Service Cards, last page.

Keys to better catalysis

. . . NORTON Ceramic Catalyst Carriers

In modern chemical and petrochemical process reactions, very often the choice of proper catalyst carriers is as critical a factor as selection of the catalysts themselves. And time and again, NORTON Ceramic Catalyst Carriers have proved the *best* choice both for efficiency and economy.

It's more than just a question of a quality product. There's a personal equation involved — the Norton Man. He brings to chemical engineers the benefits of NORTON COMPANY'S years of experience in the chemical and petrochemical fields as well as the end products of its advanced manufacturing and quality control methods. He *understands* the problems involved. And, backed by NORTON COMPANY'S extensive research and engineering facilities, he's well qualified to help in their solution.

Whatever the feedstock or thermal conditions involved . . . whether reaction is in the gaseous or liquid phase . . . whether the carrier is to be coated or impregnated with the active agent, he's ready to suggest the specific NORTON product that will do the job best. He also knows that *every* NORTON Carrier gives chemical processors the assurance of highest uniformity. From lot to lot — in any quantity — size, weight, porosity, pore diameter and purity are held to close tolerances that assure precise duplication of results.

Take advantage of the service the Norton Man represents. Let him help you to meet catalyst carrier specifications exactly. It's the simple practical way to insure maximum catalyst activity and life . . . to keep catalyst costs low . . . to get optimum yield from your process. Write NORTON COMPANY, Refractories Division, 463 New Bond Street, Worcester 6, Mass.

WIDE RANGE OF TYPES AS FOLLOWS

Shapes	Materials
Spheres	Alumina
Rings	Silicon Carbide
Pellets	Fused Magnesia
Granules	Zirconia
Powders	Silica, Zircon
	Magnesia — alumina
	Spinel, etc.

Porosity — from 10% to 50%

Surface Area — from less than 1 to 70 $m^2/gram$*

*BET Method

NORTON
REFRACTORIES
Engineered . . . Rx . . . Prescribed

Making better products . . . to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — **BEHR-MANNING DIVISION** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

For more data on advertised products, use Readers' Service Cards, last page.

How to Stop VIBRATION . . in REFINERIES, PROCESS PLANTS

Send for this New Catalog—
Save Engineering Time!
Cut Construction Costs!

BARCO
"Ball Type"
Flexible Struts

Use these pre-engineered load-carrying units that save time and cut costs on many piping design projects:

SIMPLE—Eliminate need for complicated structural designing or design of special struts, tie-rods, slides, or pin and clevis arrangements.

DOUBLE ACTING—Handle both tensile and compressive loads.

LOWER COST—Almost always lower in first cost and on a life-time basis. Often reduce need for structural steel.

SAFETY—High load carrying capacity, combined with easy calculation of proper sizes promotes safety in structural design.

PRECISION BUILT—Factory machined to close tolerances and rigidly inspected. Reduces possibility of dangerous errors in field construction. Lubricated for life.

"VIBRASNUB"
Hydraulic
Vibration Snubbers

Immediately available from stock and readily adaptable to economical field use for handling rapid shock loads and restricting vibration in hot piping. Typical applications are in high temperature piping in steam plants, petroleum refineries, and process plants. The "Vibrasnub" readily allows thermal movements, but effectively restricts rapid vibration movements and momentary shock loads such as may cause dangerous stresses, annoying noise, or deterioration in structural assemblies. "Vibrasnubs" work where spring-type dampners or shock absorbers will not permit required movement. Barco can provide engineering data for solution of many vibration problems. Ask for information.

SEND FOR NEW CATALOG 229A—Illustrated with drawings and photographs showing how to reduce design engineering time and save on structural costs with new Barco "Ball Type" Flexible Struts and "Vibrasnub" Hydraulic Vibration Snubbers.

PRODUCTS BACKED BY EXPERIENCE BARCO FOUNDED 1903

BARCO MANUFACTURING CO.
5421 Hough Street • Barrington, Illinois

Flexible Joints • Structural Products • Construction Equipment
In Canada: The Holden Co., Ltd., Montreal

Men . . .

management with information, studies and recommendations concerning Gulf, the oil industry and business in general. Lutz was previously co-ordinator, Planning and Economics department.

N. J. McCracken, assistant manager of Polymer Corp.'s Research and Development division, has been placed in charge of an over-all organizational change within the division. **Dr. H. L. Williams,** who has been named projects manager, is responsible for activity in the major fields of research and development, each of which will be under a project supervisor.

Dr. Warren G. Meinschein, who received a Ph.D. degree in organic chemistry from the University of Texas in 1951, recently joined Esso Research and Engineering Co. Author of several technical papers on the origin of oil and related fields, he had been with Magnolia Petroleum Co. for seven years.

L. E. Frensley and E. J. Wacker, Jr., have been named vice presidents of Magnolia Petroleum Co. The company has formed a Petroleum Chemicals department to be headed by **R. D. Hanley,** vice president and manager of the Natural Gas department.

L. G. Barnett, Jr., D. W. Jeffrey and X. B. Reed, Jr., have joined Humble Oil & Refining Co.'s Research and Development division, Baytown, Texas. Barnett holds B.S. and M.S. degrees in chemical engineering from Tulane University, Jeffrey a B.S. degree in chemical engineering from Georgia Institute of Technology and M.S. degree from M.I.T., and Reed, a B.S. degree from Texas A&M College.

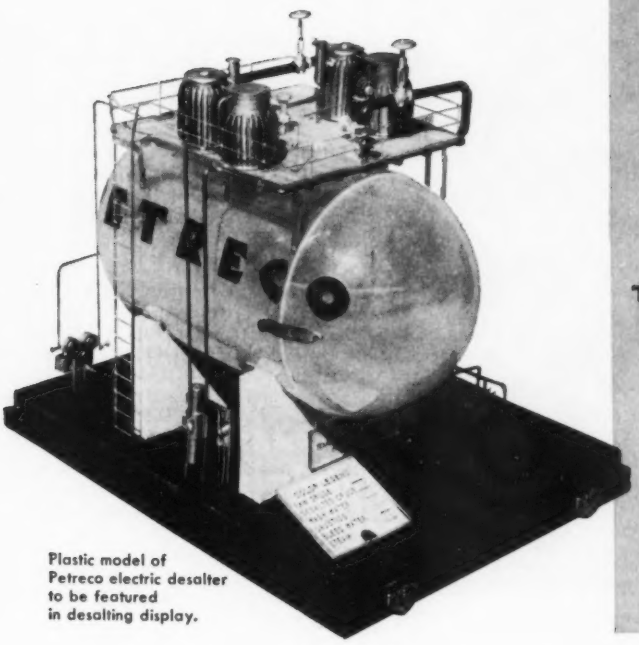
Edward H. Herrick has been appointed manager of Heyden Newport Chemical Corp.'s Garfield, N. J. plant. Since 1940 he has held supervisory positions for various production operations at the Garfield plant.

Gilbert W. Humphrey, president and director of The Hanna Mining Co., has been named a director of The Texas Co. Other new directors are **Ogden Phipps,** chairman of the board of Bessemer Securities Corp., and **Dwight P. Robinson, Jr.,** chairman of the board of Massachusetts Investors Trust.

Herbert Willetts, a member of Socony Mobil Oil Co.'s board of directors, has been named president of Mobil Oil Co., Socony's new operating division for the United States and Canada. **Herman J. Schmidt,** also a Socony director, will be president of Mobil International Oil Co., new foreign operating company. Both men will be executive vice presidents of Socony.

Hugh P. Godard, Aluminum Laboratories, Ltd., Kingston, Ont., has been named president of NACE, 1959-60

For more data on advertised products, use Readers' Service Cards, last page.



Plastic model of Petreco electric desalter to be featured in desalting display.

International Petroleum Exposition

5th World Petroleum Congress

TULSA, OKLA. May 14-23

NEW YORK, N. Y. May 30-June 5

Scale models

Animated flow diagrams

Color photomicrographs

See all these PETRECO* electric petroleum processes at the IPE and WPC shows!

ALL-ELECTRIC DESALTING. Model unit shows how salts, solids and residual BS & W are removed *automatically* from crude.

ELECTROFINING*. Flow charts and photographs offer evidence of this highly efficient way to remove acids, H_2S, mercaptans, cresols, thiocreosols, sulfur compounds, arsenic, lead, etc., from light to middle range distillates.

BENDER CATALYTIC SWEETENING. 3-dimensional flow diagram. Shows modern, low-cost way to sweeten gasoline, jet fuel, kerosine and heat oil without volume loss, air or stream pollution.

ELECTRIC DEHYDRATION. Graphic display shows automatic and safety features of Petreco electric dehydrating precipitator.

SEDIMENT SEPARATION. 70x photomicrographs of crude oil before and after treatment demonstrate efficiency of sediment removal by Petreco precipitator.

POLLUTION CONTROL. Graphic case history display features examples of how Petreco processing equipment prevents air and stream pollution.

WE'LL BE LOOKING FOR YOU!

IPE: W. side of Drumright Ave., N. of Scientific and Technical Bldg., Tulsa exposition grounds.

WPC: Booth #97, 1st Fl., Coliseum, New York City.

*Registered trademarks of Petrolite Corporation.

PX-59-1

PETROLITE CORPORATION

PETRECO DIVISION

3202 South Wayside Drive (P.O. Box 2546), Houston 1, Texas

1390 East Burnett Street (P.O. Box 7216), Long Beach 7, California

CANADA: Petreco, 4528 Stanley Drive, Calgary, Alberta

ENGLAND: Petrolite Limited, 46 Mount Street, London, W. 1

VENEZUELA: South American Petrolite Corporation, Hotel Avila, Caracas

REPRESENTATIVES

BRAZIL: WERCO, Ltda., Avenida Rio Branco 57-s/1410-11, Rio de Janeiro

COLOMBIA: South American Petrolite Corporation, Calle 19, No. 7-30, Office 807, Bogota

ITALY: O. Wagner, 149 Via Nemorense, Apt. 1, Rome

JAPAN: Chiyoda Chemical Engineering and Construction Company, Ltd., Tokyo Bldg., No. 3, Marunouchi 2-Chome, Chiyoda-Ku, Tokyo

KUWAIT: F. N. Dahdah, Box 1713, Al Kuwait

MEXICO: R. E. Power, Sierra de Mijes, No. 125, Mexico D. F.

NETHERLANDS: F. E. C. Jenkins, Hoefbladlaan 134, The Hague

TRINIDAD: Neal and Massy, Ltd., Port of Spain, P. O. Box 544

One of 7 Austin-Western hydraulic cranes of Tidewater Oil Company's new Delaware City refinery shown hoisting a section of pipe at a catalytic cracking unit.

AUSTIN-WESTERN HYDRAULIC CRANE

One of Tidewater's most versatile construction and maintenance tools

Thirty-six Austin-Western hydraulic cranes helped build Tidewater's giant refinery near Delaware City, Del., and seven are now steadily employed handling materials and speeding repairs. They are among the most versatile construction and maintenance tools Tidewater has, and new jobs are being found for them every day.

Here are some of the ways Austin-Westerns save time and money on refinery operations: they remove heat exchanger heads and tubes quickly, eliminating the need for a larger crane or chain blocks; lift and transport pumps into the machine shop for repairs, spotting them precisely; unload freight cars, using their long, live booms fast and efficiently, transport materials with ease under lines in pump alleys and around pumphouses, over railroad tracks, in and out of buildings.

Find out how the flexible Austin-Western hydraulic crane can help you. See your nearby distributor or write direct.

Austin 1859 AUSTIN-WESTERN 1959 100th YEAR PARTNERS IN PROGRESS Western
CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.
BALDWIN · LIMA · HAMILTON
Power graders • Motor sweepers • Road rollers • Hydraulic cranes

Men . . .

term. Vice president will be **George E. Best,** Solvay Process division, Allied Chemical Corp.; and treasurer, **A. L. Stegner,** Tennessee Gas Transmission Co.

J. W. Keener, president of The B. F. Goodrich Co., Akron, has been reelected a board member of the National Industrial Conference Board for a term of one year.

James R. Glennon has been named manager of employee relations research in the central Employee Relations department, Standard Oil Co., (Ind.). He joined Standard in 1951 as a market research analyst, Distribution Economics department.

R. P. Medlin has joined the Economics department, Magnolia Petroleum Co. He was formerly chief process engineer in charge of the Technical department Planning and Coordinating section. He will be engineering supervisor on economics problems relative to refinery planning and operations.

Donald G. Stevens, manager of the Manufacturing division, Petrochemical department, The Standard Oil Co. (Ohio), Lima, Ohio, has been named manager of the department. He joined Sohio in 1941 in the Technical Service division and became its chief in 1949.

T. R. B. Watson, founder of Corrosion Services, Ltd., Toronto, Ont., has been named Canadian region director of NACE. **J. C. Spalding,** Sun Oil Co., Dallas, will represent the South Central region and **E. F. Moorman,** International Harvester Co., Chicago, will represent the North Central region.

D. W. Juenker, assistant professor of physics at Notre Dame University received NACE's 1958 Young Author Award in March. The award was given on the basis of a paper published in the January issue, *Corrosion* magazine, the association's periodical.

William W. Scull, with the B. F. Goodrich Co. since 1929, has been elected vice president-manufacturing. Director of manufacturing services since 1954, he was director of purchasing and traffic since 1952.

Dr. Abraham Schneider has been named a research scientist in Sun Oil Co.'s Research and Development division. Previously manager of basic research, he joined Sun as a chemist in 1945.

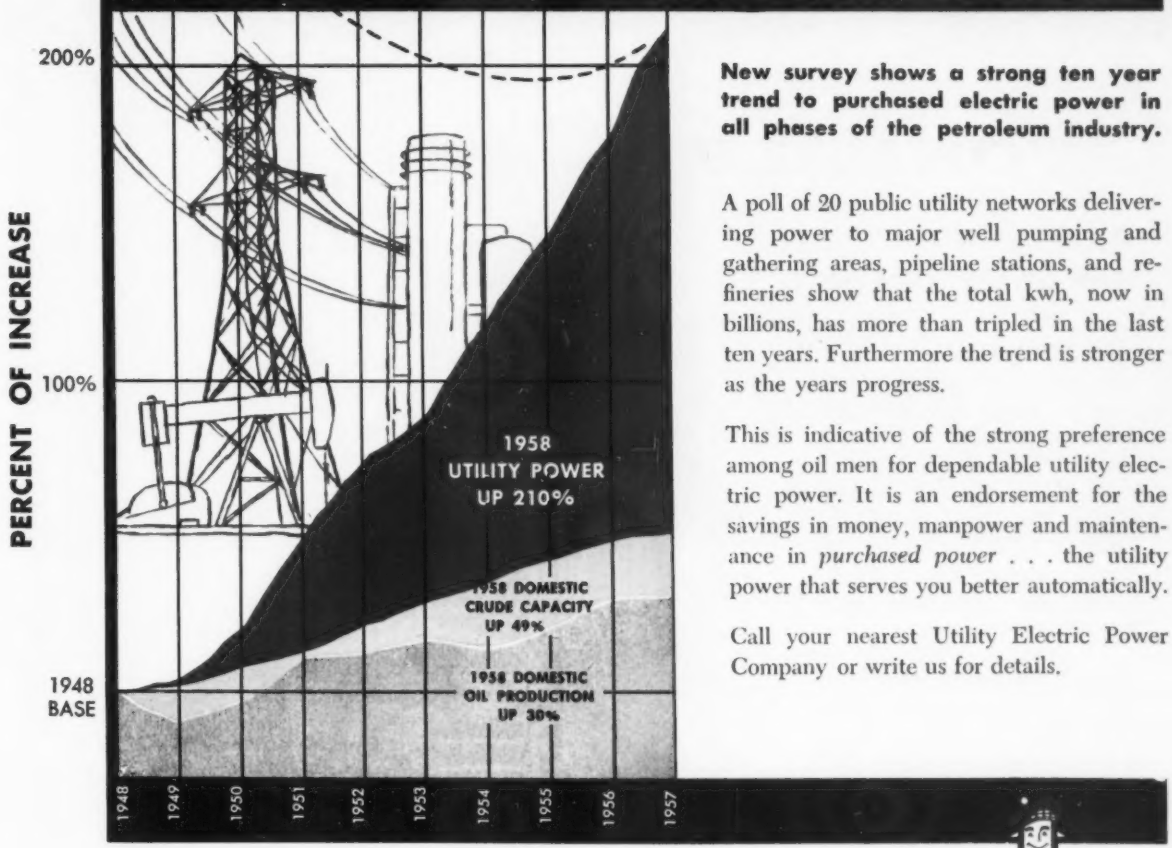
Arthur L. Conn has been assigned to technical service for Standard Oil Co. (Ind.) Other transferees and their new

For more data on advertised products, use Readers' Service Cards, last page.

210% increase

in the use of Utility Electric Power

IN WELL PUMPING, PIPELINES AND REFINERIES



New survey shows a strong ten year trend to purchased electric power in all phases of the petroleum industry.

A poll of 20 public utility networks delivering power to major well pumping and gathering areas, pipeline stations, and refineries show that the total kwh, now in billions, has more than tripled in the last ten years. Furthermore the trend is stronger as the years progress.

This is indicative of the strong preference among oil men for dependable utility electric power. It is an endorsement for the savings in money, manpower and maintenance in *purchased power* . . . the utility power that serves you better automatically.

Call your nearest Utility Electric Power Company or write us for details.

Purchased Electric Power . . .
saves money, manpower, maintenance
and serves you better automatically

Petroleum Electric Power Association

P.O. BOX 35006, DALLAS 35, TEXAS

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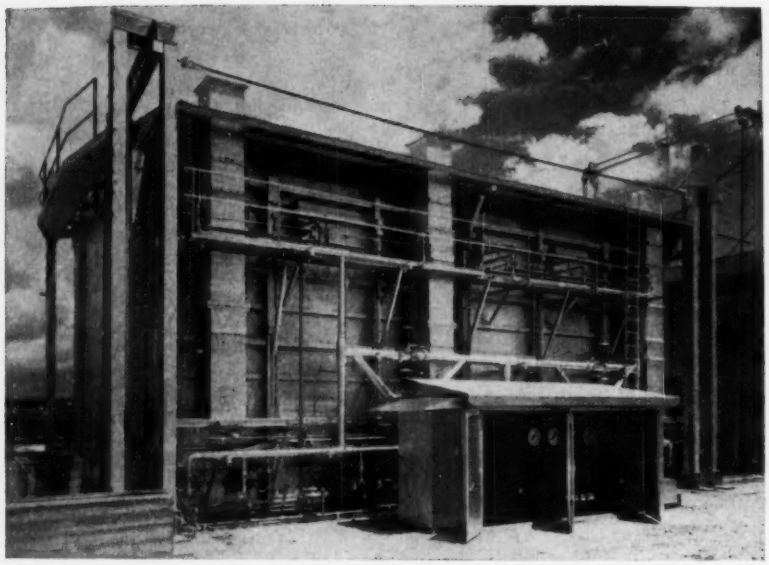
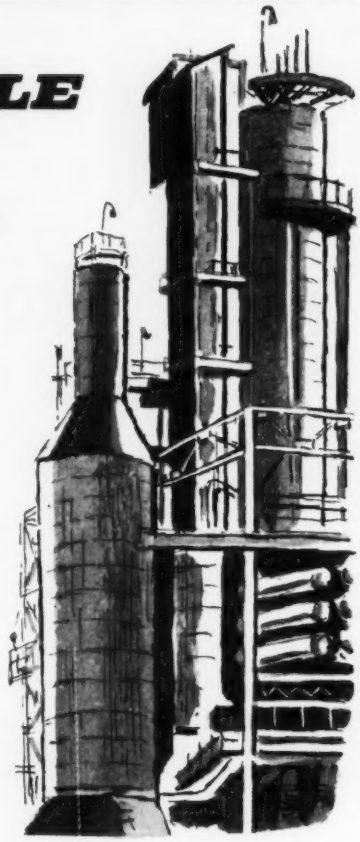




AVONDALE

a new name in the chemical field

NEW FACILITIES . . . at Avondale Marine Ways now make it possible to offer a wide range of products and services directly to the chemical and petrochemical industries. In addition to large plate rolls for heavy steel fabrication, there is the specially designed, automatically controlled furnace with temperatures up to 2100°F. shown above.

Through the use of these facilities, Avondale can produce ASME Code Stamped pressure vessels to 4 in. thickness and up to 18 ft. in diameter and 300 ft. in length.

Write for our complete brochure, *Heavy Steel Fabrication*

Industrial Division
AVONDALE
MARINE WAYS, INC.
VERSATILE BUILDER ON THE MISSISSIPPI
416 ERATO ST. • JAckson 2-3836 • NEW ORLEANS 13, U.S.A.

Men . . .

areas: **Clarence M. Loane,** hydrocarbon research; **William F. Meehan,** process development; **Robert A. Steel,** process design and economics; and **Glenn M. Webb,** lubricants research. Conn formerly headed the Process Design and Economics division, Dr. Loane directed lubricants research, Meehan superintended technical service at Whiting, and Steel has been director of process development.

Whitney Stone has been elected chairman of the board and chief executive officer of Stone & Webster Engineering Co. **Richard N. Benjamin** was elected president and director.

R. Tesoro has been named assistant plant manager, operations, Jefferson Chemical Co.'s Port Neches, Texas plant. **R. H. Darling** will be assistant plant manager, engineering, construction and maintenance; **E. R. Cobb,** chief processing engineer, and **C. H. Moore,** chief engineer, Engineering and Maintenance division.

Marian E. King, holder of a B.S. degree from Drexel Institute School of Library Science, has joined Esso Research and Engineering Co. Miss King had been assistant librarian for the Hercules Experimental Station Library, Wilmington, Del.

Richard Graham Adams, graduate of Brown University in 1950 with a B.S. in chemistry, has joined Esso Research and Engineering Co. He was previously a plastics technical service engineer for Owens Corning Fiberglas Corp., Ashton, R. I.

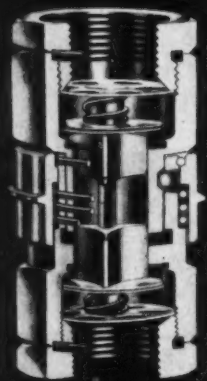
Don C. Miller, formerly senior vice president of Kenyon and Eckhardt, Inc., advertising agency, has been named vice president-marketing of The B. F. Goodrich Co.

Ener H. Nelson, formerly chief process engineer in charge of Process Engineering laboratories at Magnolia Petroleum Co.'s Beaumont, Texas, refinery, has been transferred to Dallas headquarters. He became supervisor of company proj-

Free to PETROLEUM REFINER Subscribers

Write for free booklet on preparation of articles for PETROLEUM REFINER, the technical press generally, as well as papers for technical meetings.
Use Reader's Service green cards in the back of this issue. Write on the card "Free Author's Booklet," fill in name, address and mail. No charge, no obligation.

For more data on advertised products, use Readers' Service Cards, last page.



Provided with valves to give two-way or one-way automatic line shut off.

Built to handle high pressure hydraulic and pneumatic systems

Snap-Tite *valved* couplings stop flow instantly"

Snap-Tite provides instant shut-off wherever fluid coupling is needed.

Snap-Tite *valved* couplings connect and disconnect quickly and fully—they automatically open line flow when connected; positively seal your line when disconnected—with no "ifs," no chance for human error.

Snap-Tite couplings are available in sizes from ¼" to 6" ID, in steel, brass, aluminum, 303 ss and 316 ss. Sizes from 6" to 10" ID are available on special order. For more information, write for Snap-Tite catalog №58. Snap-Tite representatives are located in all principal cities.

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS

★ Snap-Tite

SNAP-TITE, INC. • UNION CITY, PA.

ST-59-01

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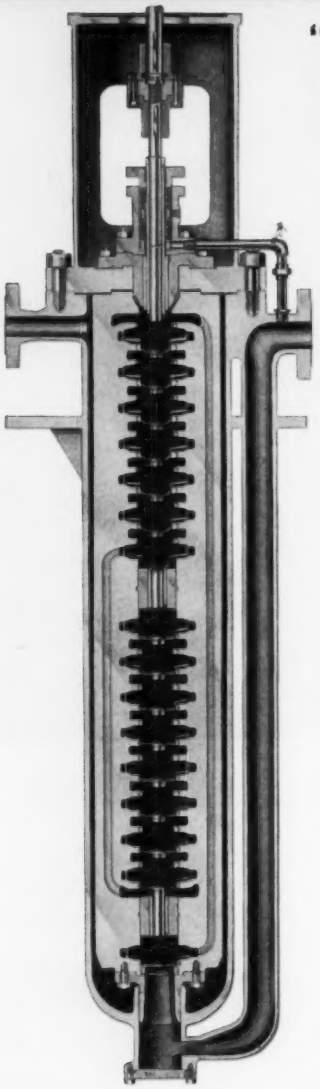
Bingham

DOUBLE VOLUTE DOUBLE CASE "HI-PRESS" PUMP

FOR EXTREMELY HIGH PRESSURES HOT OR COLD SERVICE



"DOUBLE VOLUTE" DESIGN PROVIDES HYDRAULIC RADIAL BALANCE OF ROTATING ELEMENT . . . NO "SIDE PUSH" . . . ELIMINATES WEAR AND SEIZURE

The "Double Volute" construction of Bingham Multistage "Hi-Press" Pumps insures perfect radial balance of the rotating element, under all operating conditions . . . completely eliminating wear between rotating and stationary parts. "Double Volute" construction permits maximum use, without exceeding normal clearances, of non-corrosive metallurgy—particularly austenitic steel—normally considered dangerous on account of their galling and seizing characteristics.

This feature also eliminates shaft deflection, permitting **mechanical seals** to establish and maintain a uniform track between contacting faces. This prevents leakage and seal face wear, resulting in **long life for all mechanical seals.**

"Double Volute" design also permits the pumpage to be discharged from the inner into the outer case through two nozzles located 180° apart. For hot service, this feature provides adequate circulation of pumpage between the two cases, insuring a uniform temperature rise in all parts – thereby eliminating distortion due to temperature changes.

Location of suction and discharge at top of pump case is particularly suitable for low NPSH conditions.

Write your nearest Bingham office for full information.

Diagram of a "Double Volute" double discharge case of a multi-stage pump (right) showing the equal pressure on the opposite sides of impeller. There is no "SIDE-PUSH", insuring low maintenance.

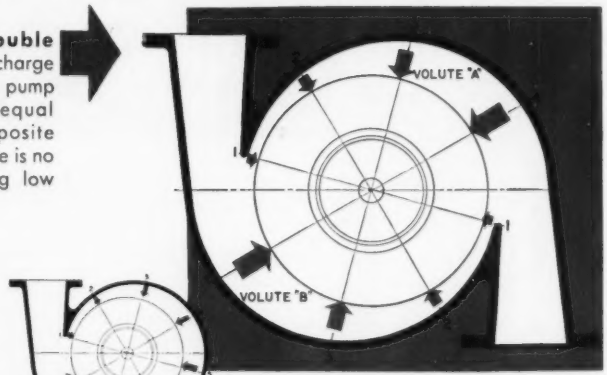


Diagram of "Single Volute" pump case (left) showing unequal pressures at opposite points around the periphery of the impeller. These unequal pressures cause "SIDE-PUSH" on the rotating elements, causing wear of rotating parts and, frequently, high maintenance.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY
General Offices: **2800 N. W. Front Avenue, Portland 10, Oregon**
Factories: **Portland, Ore. • Vancouver, B. C., Canada**

SALES AND SERVICE OFFICES

BOSTON, MASS.	NEW YORK CITY, N. Y.
CHICAGO, ILL.	PHILADELPHIA, PA.
CLEVELAND, OHIO	PITTSBURGH, PA.
DALLAS, TEXAS	SAN FRANCISCO, CALIF.
DENVER, COLO.	SEATTLE, WASH.
HOUSTON, TEXAS	ST. LOUIS, MO.
KANSAS CITY, MO.	ST. PAUL, MINN.
LOS ANGELES, CALIF.	TULSA, OKLA.
NEW ORLEANS, LA.	TORONTO, ONT., CAN.

VANCOUVER, B. C., CAN.

Men . . .

ects and programs in the Economics department. **W. P. Wallace,** assistant chief chemist in the Product Control laboratories, became chief process engineer.

Dr. Edward G. Baker has been named a research associate in the Chemicals Research division, Esso Research and Engineering Co., Linden, N. J. He joined the company eight years ago after receiving a Ph.D. degree in physical chemistry from Brown University.

R. C. Woerner, director of engineering, Petro-Tex Chemical Corp., Houston, has been named plant manager. Other appointments: **J. B. Willis,** director of engineering; **D. V. Fitz,** general superintendent; **H. A. Harrison,** assistant general superintendent; **C. H. Sloan,** production superintendent; and **T. A. Rodgerson,** process superintendent.

Everett W. Hubbard, Jr., has been named assistant to the vice president in charge of refining, Kerr-McGee Oil Industries, Inc., Oklahoma City. Formerly senior mechanical engineer at the company's Cushing, Okla., refinery, he is a graduate of Oklahoma State University.

Homer C. Wilson has been appointed manager of operations, Texas Butadiene & Chemical Corp., Houston. Formerly director of supplies, he was manager of Celanese Corp.'s Petrocel division, Corpus Christi, before joining the company.

Harold W. Haight has been named chairman of Carter Oil Co.'s board of directors. Formerly president and director of Creole Petroleum Corp., he has been with the Standard Oil Co. (N.J.) organization since 1927.

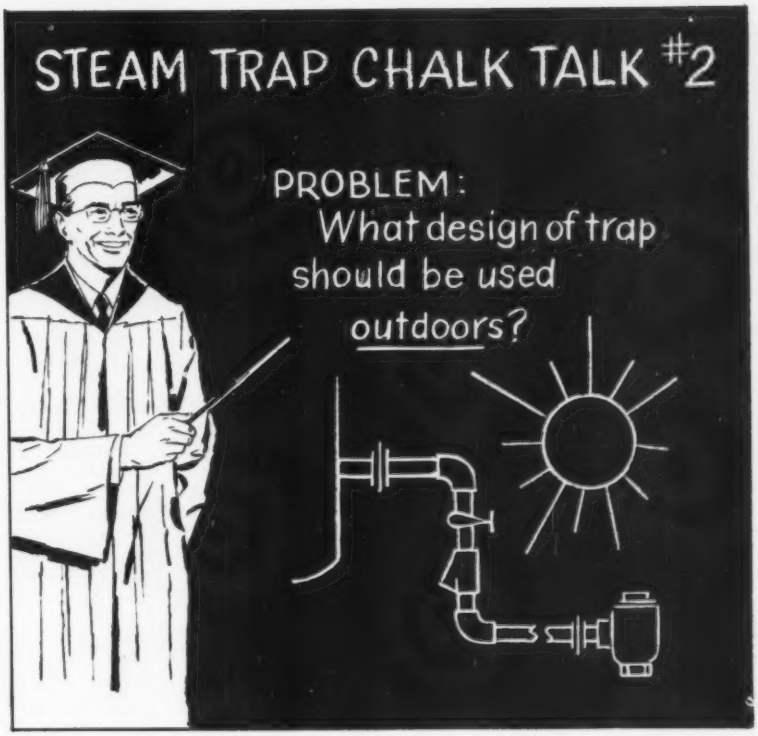
Paul D. Williams has been re-elected secretary-treasurer of the WPRA. Williams, located at the Association's Tulsa headquarters, has held the position since 1955.

E. Finley Carter has been named president of Stanford Research Institute and will be a member of the board of directors' executive committee. **Weldon B. Gibson** has been named vice president and member of the board.

E. J. McClanahan, vice president and director of Standard Oil Co. of Calif. and chairman of the board of Western Operations, Inc., has retired. He joined the company in Seattle, 1912.

– Deaths –

Harry D. Frueauff, 83, retired executive of Cities Service Petroleum, Inc., died March 16 in New York after an extended illness. In 1950, he was appointed vice president of the company, serving as such until his retirement. He was also vice president of Cities Service Oil Co. and for many years was a director of API.



- First, use Anderson Quik-Flex thermostatically designed steam traps. These traps have no pockets in which water will collect and freeze. An open pipe on the discharge side provides constant drainage and eliminates any maintenance during freezing temperatures.

Second, use a cooling leg of at least three feet. Thermostatic traps operate on temperature differential, and sufficient piping must be provided for the condensate to cool.

Third, install the strainer in a down position. Strainers in horizontal positions collect condensate which freezes and breaks the strainer body during cold weather.

Anderson Quik-Flex Steam Traps are built especially for outdoor service. Guaranteed freeze-proof for two years, they provide a lifetime of trouble-free, freeze-proof draining of condensate from steam lines. Mail coupon for complete details.

A TRAP FOR EVERY PURPOSE

THE V. D. ANDERSON COMPANY
division of International Basic Economy Corporation
1953 West 96th Street • Cleveland 2, Ohio

Please send without obligation your catalog describing Anderson freeze-proof Quik-Flex Thermostatic Steam Traps.

Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____

ANDERSON **QUIK-FLEX**

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers Notes...

Johnson

Gifford K. Johnson has been named president of Genesys Corp., Los Angeles. Formerly vice president of production at Chance Vought, Aircraft, Inc., he will be a director and vice president of that company, responsible for corporate business planning. At Genesys, Johnson will direct the program in advanced control computer systems for the petroleum processing and chemical industries. He attended Santa Monica Junior College and UCLA.

Schaefer

Charles Schaefer has been appointed general sales manager of the Permanent Filter Corp., Los Angeles. He previously held top sales positions with European and U.S. manufacturing firms, the latest being general sales manager of the West Coast branch, S & S Machinery Co. He will direct over-all sales activities for Permanent Filter. Schaefer attended colleges in Berne, Switzerland, and Brighton, England, majoring in mechanical engineering.

Barcal

Edward J. Barcal, Jr. has been named territory manager for the midwestern territory of the Alloy Tube division, The Carpenter Steel Co. He will cover Northern Illinois, Wisconsin, Minnesota, North Dakota and South Dakota. Before joining Carpenter, he was an engineer-accountant for Chicago Northwestern Railroad Co., and a salesman for Economics Laboratories, St. Paul, Minn. In this capacity he covered Northern Illinois and Chicago territories.

Taylor

Dr. J. Earl Taylor has been named manager of research and development for Girdler Catalysts, a unit of Chemetron Corp.'s Chemical Products division. He had been market development manager for Girdler since 1954 and will incorporate that function in his new position and take charge of a new diversification and long-range research program. Dr. Taylor received his M.S. and Ph.D. degrees from Ohio State University.

Breit

Karl K. Breit has been named chief sales engineer for Richard C. Remmey Son Co., Philadelphia. He will be in charge of the Sales Engineering department. Breit was previously a member of the Sales Engineering department, A. P. Green Fire Brick Co., working out of the company's main office at Mexico, Mo. He is a graduate of Rolla School of Mines and Metallurgy, Rolla, Mo.

Burke

Harry E. Burke, Jr., has been named vice president and general manager of Consolidated Systems Corp., a new subsidiary of Consolidated Electrodynamics Corp. He joined Consolidated Electrodynamics in 1947 as an electronic engineer after wartime service as a submarine radar and sonar expert with the Navy. He became assistant director, Systems division, in 1954 and director a year later. Burke has B.S. and M.S. degrees in electrical engineering.

Formato

Richard A. Formato has been appointed sales manager of the Southeastern division, Carlon Products Corp. Previously a Carlon sales representative in Virginia, Maryland and Washington, D. C., Formato attended Ohio University and graduated from Western Reserve University. He has been with Carlon six years, having served as sales promotion manager two years before joining the sales force. He will locate at Carlon's Southeastern division sales office, Asheville, N. C.

Reed

Robert Reed has been promoted to the newly-created post of vice president in charge of engineering by the John Zink Co. Formerly the company's chief engineer, Reed joined Zink in 1936. After attending Oklahoma State University he became a newspaper reporter and later worked for Continental Oil Co., Navajo Refining Co., and was chief engineer for Baseball, Inc. He is a registered professional engineer and member of ASME.

Cutler

Ralph Cutler has been named a vice president of Yuba Consolidated Industries, Inc., and general manager of Southwest Welding and Manufacturing division. He was previously with Kaiser Steel Corp., as manager of engineering and estimating, Fabricating division. Since graduating from California Institute of Technology in 1929, Cutler has held a number of executive positions in many phases of steel engineering and fabricating.

Purcell

Frank E. Purcell has been named sales manager of packaged equipment for the Unitary Equipment division, Carrier Corp. Formerly sales manager of the National Buyer department at Carrier, he will be in charge of air conditioning and heating equipment for both residential and commercial application. Before joining the company in 1940, Purcell was co-owner and president of Triangle Sales-Appliance Corp.

$AlCl_3$

ALUMINUM CHLORIDE

The increasing use of Aluminum Chloride and the many new uses being found for it have led to a large increase in demand. In response to the need, Stauffer has increased production and refining capacity . . . is today, indeed, the country's largest producer.

PROMPT shipments of Anhydrous Aluminum Chloride are made from Houston, Baton Rouge and Elkton, Md., in drums of 600, 100 and 50 pounds net capacity.

Stauffer's Anhydrous Aluminum Chloride is made in granular or powder form, in six grades and numerous mesh sizes. Aqueous Aluminum Chloride is available on the West Coast only. Typical analyses of all grades of Stauffer's Aluminum Chloride comfortably surpass all specifications as to minimum $AlCl_3$ content, and maximum impurities.

Stauffer is also a major source of chlorides of Antimony, Boron, Silicon, Titanium and Zirconium. New book available on Metallic Chlorides; copies on request.

stauffer means service

Stauffer CHEMICALS SINCE 1885

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, N. Y.

Prudential Plaza, Chicago 1, Ill. • 636 California Street, San Francisco 8, Calif.

P. O. Box 9716, Houston 15, Texas

For more data on advertised products, use Readers' Service Cards, last page.

BIRD-ARCHER'S 8 POINT WATER TREATMENT PROGRAM

Designed for Inplant Testing... Performed by Your Personnel... Backed by Experts

If you use water for power, process or cooling, it will pay you to look into Bird-Archer's 8 point Water Treatment Service. Every step in this Service is performed by qualified chemists and engineers whose main task is to design a system that can be implemented by *your own personnel* and at the same time place at your disposal *60 years' experience* in solving water treatment problems.

Bird-Archer's 8 Complete Engineering Services

- Complete studies of your use of water or steam.
- Exhaustive analysis of water supplies starting at source.
- Modern laboratory with seasoned chemists specializing in water analysis and research.
- Operational changes where necessary.
- Custom formulated chemical treatments for your specific needs.
- Complete analysis of savings and benefits where additional equipment may be helpful.
- Instruction of your personnel by experienced technicians in accurate control and test procedures.
- Periodic call-backs by your Bird-Archer Service Engineer to be sure you continue to get the best possible results.

A Bird-Archer 8 Point Service Engineer is only a "phone's throw" away. Call him for greater peace of mind.

BA-800

BIRD-ARCHER
WATER TREATING CONSULTANTS
The BIRD-ARCHER Company, 4337 N. American St., Phila. 40, Pa.
New York • Chicago
The BIRD-ARCHER CO. of California, 415 Brannan St., San Francisco • Offices in Canada and Mexico

Suppliers . . .

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO. has named **Newton E. Armstrong,** manager, Systems Development division. He is responsible for control-application instrument development in the chemical, petrochemical, and process industries.

WALSH REFRACTORIES CORP. has named **A. J. Tomasek** chief executive officer and chairman of the board. He had been president of the firm.

Reed

Beardslee

GENERAL ELECTRIC CO.'s Metallurgical Products department, Detroit, has named **Dr. Charles E. Reed** general manager. He succeeds **Kenneth R. Beardslee,** who will be a consultant for the department. A M.I.T. graduate with a D.S. degree in chemical engineering and former assistant professor of chemical engineering there, Dr. Reed has been general manager of the Silicone Products department, General Electric, Waterford, N. Y., for seven years.

PFAUDLER PERMUTIT, INC. has transferred Vice President **George C. Calvert,** previously manager of the Elyria plant, to Rochester to supervise Western hemisphere operations outside the United States. He will also assist in supervising foreign operations. **E. W. Zoller** will be manager of domestic manufacturing operations, Pfaudler division. He joined Pfaudler in 1933, and in 1956 was made manager, Rochester plant.

OAKITE PRODUCTS, INC. celebrated its 50th anniversary in the industrial cleaning business on February 2. Formerly Oakley Chemical Co., the firm became Oakite Products in 1926. The company was founded by **David C. Ball** and his associates, **Daniel C. Smith** and **George W. Oakley.** It now has 17 U.S. divisional offices and 250 employes.

FISCHER & PORTER CO., Hatboro, Pa., has appointed **Horace F. Richter, Jr.,** sales coordinator. He will implement sales policies, coordinate operating activities between the home office and its field force, and direct the sales training program.

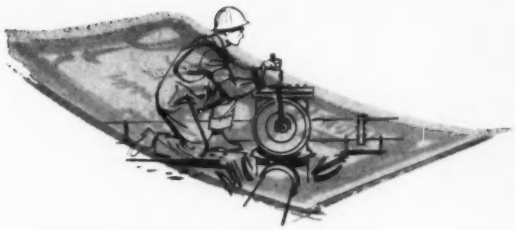
BRIDGEPORT BRASS CO. has appointed **Douglas C. Graham,** formerly sales manager of the Condenser Tube division, assistant sales manager of brass mill products. **Philip E. Bush,** manager of the Philadelphia sales district, becomes manager, Condenser Tube division. **William**

For more data on advertised products, use Readers' Service Cards, last page.

Save dollars 4 ways with UNICOR®

1. Maintain flow capacity

Unicor prevents corrosion in pipelines—keeps pipelines free of scale. With Unicor you are assured of maintaining maximum flow capacity, C factor and output.

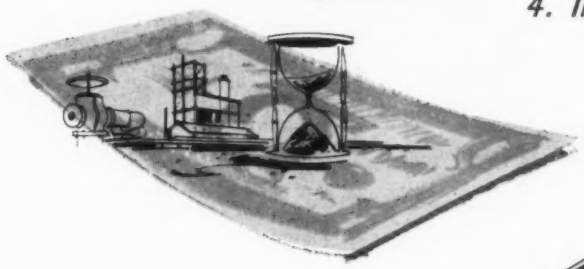


2. Reduce downtime

Downtime to scrape lines and replace filters is production time lost. Prevent such loss with Unicor. It keeps equipment free of products of corrosion.

3. Cut filter replacements

What's your annual bill to service and replace filters? A pretty penny, no doubt. You can drastically reduce this expense by using Unicor.



4. Increase equipment life

Tanks, vessels and pipelines stand up longer when you give them effective protection against corrosion. A little Unicor goes a long way—protects against corrosion from well to consumer.

Unicor, the preferred oil-soluble corrosion inhibitor, can be added to your product at any point in your operation. Costs less than a tenth of a cent per barrel of product. Write our Products Department for detailed information. Ask about samples and how to test them.

UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road,
Des Plaines, Illinois, U.S.A.

More Than Forty Years Of Leadership In Petroleum Refining Technology

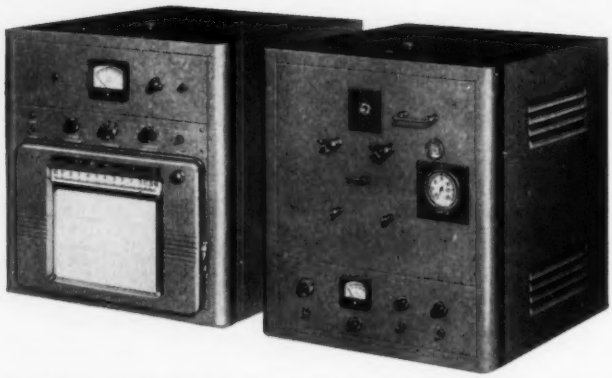
For more data on advertised products, use Readers' Service Cards, last page.

THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments

Newest idea in gas chromatography... Wheelco's Ionization Detection System



First Commercially Produced Units Using Ionization Detectors and Capillary Columns

Extreme sensitivity of Wheelco's Model 20 results from the combination of the advanced-design detector with capillary columns up to 2000 feet long. Sensitivities approaching 10^{-15} moles have been obtained as have theoretical efficiencies of over 200,000 theoretical plates from a 200 ft capillary column.

Ionization Detection Systems normally use argon as an ionizing carrier. Organic and other gases are ionized in the detector cell by the transfer of energy from argon's metastable atoms to the specimen atoms. This provides an electrical current increment — and therefore a sensitivity — far greater than with conventional thermal conductivity methods.

Here are other features, many of them exclusive on Wheelco's Model 20:

Dual Sensitivity Controls — provided by 7 ranges of electrometer sensitivity plus a continuously variable 0-2000v d-c power supply.

Flash Heater — operates to 300°C; provides rapid volatilization of sample specimens.

Detection System — single ionization cell serves as detector — no reference cell is required.

Precise Temperature Control — maintained to ± .3°C over 25°C to 250°C range. Cooling coil is optional extra.

Unusually Stable Operation — detector cell is relatively insensitive to changes in flow rate, small temperature changes have little effect on the base line.

Matched Recorder — system is designed for peak operating efficiency with Wheelco 8000 Series 0-50 MV range, potentiometer-type recorder.

Nationwide Sales and Service — branches in all principal cities provide added backing for Wheelco Ionization Detection Systems. Bulletins F-9263 and F-9308 have more details. Write Wheelco for your copies.

BARBER-COLMAN COMPANY

Dept. P, 1597 Rock Street, Rockford, Illinois, U.S.A.

Suppliers . . .

Brown, manager of distributor sales, Plumbing and Heating division, will be sales manager. Assistant division sales manager will be **Kenneth S. Case,** manager, Indianapolis sales district. A new sales district has been created in Tampa, Fla., with **David R. Fulton,** formerly a resident salesman there, district manager.

JAS. P. MARSH CORP. has named **A. D. Rose** president. Formerly executive vice president, he joined Marsh in 1918. He became assistant to the sales manager and then general sales manager. He organized the company's first Engineering and Development department, became vice president and assistant general manager in 1942 and guided company affairs during the war. After the war, as general manager, he directed the company's development.

Rose

U. S. RUBBER CO. has appointed **Albin S. Krivitsky** to the Synthetic Rubber and Rubber Chemical Technical Service department, Naugatuck Chemical division. He was previously technical superintendent, Boston Woven Hose and Rubber Co.

BUELL ENGINEERING CO., INC. has appointed **Schaeffer Specht** to its sales staff, New York. He was formerly assistant sales manager of Research-Cottrell, Inc.

WYATT METAL & BOILER WORKS, INC. has brought its Corpus Christi, Texas, plant to the standards required for ASME code pressure vessel fabrication, and it is reportedly prepared to produce and service pressure vessels.

SHAND AND JURS CO. has elected **Peter C. Jurs** executive president responsible for production operations. He has been a vice president of the company since 1954, in charge of the Mechanical Products division.

BLAW-KNOX CO., Pittsburgh, has appointed **Bruce Alexander** manager of advertising and marketing services. He was previously with the Chemical Plants division where he has held various engineering, sales, sales promotion, and supervisory jobs.

PENNSALT CHEMICALS CORP. has elected **Henry M. Chance II,** president of United Engineers & Constructors Inc., to the Pennsalt board of directors. A civil engineering graduate of the University of Pennsylvania, he is a registered professional engineer in New York and Pennsylvania.

KEASBEY & MATTISON CO. has named **Daniel Shoemaker,** formerly general sales manager, Industrial Products division, assistant to the general sales manager,

For more data on advertised products, use Readers' Service Cards, last page.

Higher octane levels and longer catalyst life ...with existing equipment...merely by replacing with Sinclair-Baker RD 150 Platinum Catalyst

REGENERATES IN SITU!

If you have the problem of increasing octane rating and production in your existing equipment, investigate the unique performance of Sinclair-Baker RD 150 Platinum Reforming Catalyst. Its efficiency in producing *important yield increases at high octane levels* is a matter of record. The long period of RD 150 operation is unmatched by any other catalyst . . . further, *it is regenerative in situ!* Cost is sharply reduced to lowest level.

ENGELHARD INDUSTRIES, INC.

EXECUTIVE OFFICES:

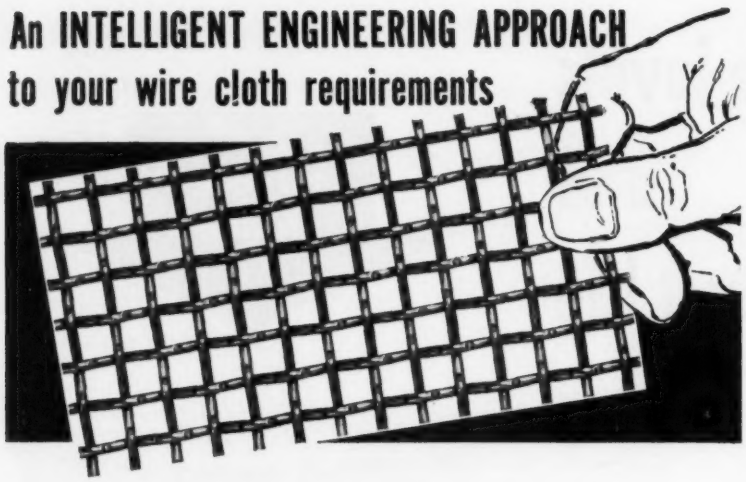
113 ASTOR STREET • NEWARK 2, NEW JERSEY

CHEMICAL DIVISION

DOMESTIC DIVISIONS: AMERICAN PLATINUM & SILVER DIVISION, AMERSIL QUARTZ DIVISION, BAKER CONTACT DIVISION, BAKER DENTAL DIVISION, BAKER SETTING DIVISION, BAKER PLATINUM DIVISION, CHEMICAL DIVISION, EAST NEWARK INDUSTRIAL CENTER, HANOVIA LAMP DIVISION, HANOVIA LIQUID GOLD DIVISION, IRVINGTON-BAKER REFINING DIVISION, D. E. MAKEPEACE DIVISION, NATIONAL ELECTRIC INSTRUMENT DIVISION, RESEARCH AND DEVELOPMENT DIVISION, H. A. WILSON DIVISION. COMPANIES ABROAD: ENGELHARD INDUSTRIES OF CANADA, LTD. TORONTO, ENGELHARD INDUSTRIES OF QUEBEC, LTD. MONTREAL, ENGELHARD INDUSTRIES, LTD. LONDON, ENGELHARD INDUSTRIES A. G. ZURICH, ENGELHARD INDUSTRIES PTY., LTD. MELBOURNE, SOCIEDAD SURAMERICANA DE METALES PRECIOSOS S. A. BOGOTA, INDUSTRIE ENGELHARD S. P. A. ROME, ENGELHARD INDUSTRIES OF SOUTHERN AFRICA, LTD. JOHANNESBURG. ASSOCIATED COMPANIES: ACME TIMBER INDUSTRIES LTD., SOUTH AFRICAN FOREST INVESTMENTS LTD., SOUTH AFRICA, AZOPLATE CORPORATION, CHARLES ENGELHARD, INC., NUCLEAR CORP. OF AMERICA, INC., U.S.A.

For more data on advertised products, use Readers' Service Cards, last page.

An INTELLIGENT ENGINEERING APPROACH to your wire cloth requirements

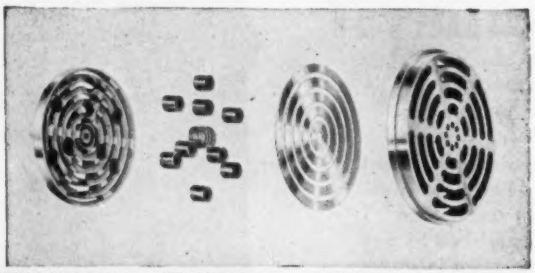


An intelligent engineering approach to wire cloth and screen requirements pays dividends. Cleveland Wire Cloth, knowing alloy, tolerances, openings, crimping and tightness of weave, study the materials being processed, processing conditions and the end results before specifying any wire cloth. They may select from hundreds of unsurpassed quality cloth in stock, or if necessary, will weave a screen for your needs. Contact Cleveland today for an intelligent engineering approach to your wire cloth and fabricated screen problems. Ask for Bulletin No. 10.

SEE OUR AD IN REFINERY CATALOG

THE CLEVELAND WIRE CLOTH & MFG. CO.
3571 EAST 78th STREET, CLEVELAND 6, OHIO • DI 1-1832

VOSS VALVES in your machine mean



LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

- up to 40% more valve area • minimum pressure loss • higher efficiency
- less power consumption • normal discharge temperature
- quiet, vibration-free • utmost safety • lower operating costs

VOSS VALVES are made to specification, machined from solid stock (not cast)—using best alloy steels; for corrosion condition—stainless steels, such as 410, 18-8 or non-ferrous alloys—monel, inconel, etc. PLATES are machined (not stamped) and ground for precise close tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. SPRINGS of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

J. H. H. VOSS VALVES REG. U.S. PAT. OFF.

J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.

Suppliers . . .

Sales division. **Walter M. Deckman** becomes general sales manager, Industrial Products division. He was formerly New York district manager. **Frank Q. Chambers** is New York district manager, having been promoted from manager, New York district Building Materials department.

OLIN MATHIESON CHEMICAL CORP. has named **G. Thomas Shantz** product manager for petroleum chemicals. He will have charge of sales and market development of oil additives, and will locate at Chemicals division headquarters, Baltimore. Shantz is a graduate of Kenyon College, Gambier, Ohio. He joined the company in 1954. Since that time, he has been a national accounts sales representative, Automotive Products department. Prior to 1954, he was with Socony Mobil Oil Co. and U. S. Industrial Chemicals Co.

Shantz

THE JOHN G. BELL CO., Los Angeles, has been named California representative of Clayton Mark & Co.

H. K. PORTER CO., INC.'s Mouldings division has appointed **Edward R. Burghardt** division controller, Detroit. He was previously assistant controller of Herron-Zimmers Moulding Co.

MALONEY-CRAWFORD TANK AND MANUFACTURING CO., Tulsa, has named **R. C. Schenk president.** He was previously with Continental Can Co. as general manager, Flexible Packaging division, Mount Vernon, Ohio.

THE INDUSTRA CO. has been appointed sales agent for Conoflow Corp. at Minneapolis. Principal of Industra is **Albert M. Belfry,** a graduate engineer.

AMERICAN CYANAMID CO. has named **John R. Burkett** general sales manager, Explosives and Mining chemicals department, with headquarters in New York.

INFILCO INC. has acquired Gale Separator Co., Bloomfield, N. J. Gale activities will be continued and merged with Infilco operations in coolant and cutting-oil cleaning and recovery.

FISCHER & PORTER CO. has named **G. A. Stiftinger** district manager, Pittsburgh office. Formerly a sales engineer for Reliance Electric & Engineering Co., he is an electrical engineering graduate of Pennsylvania State University.

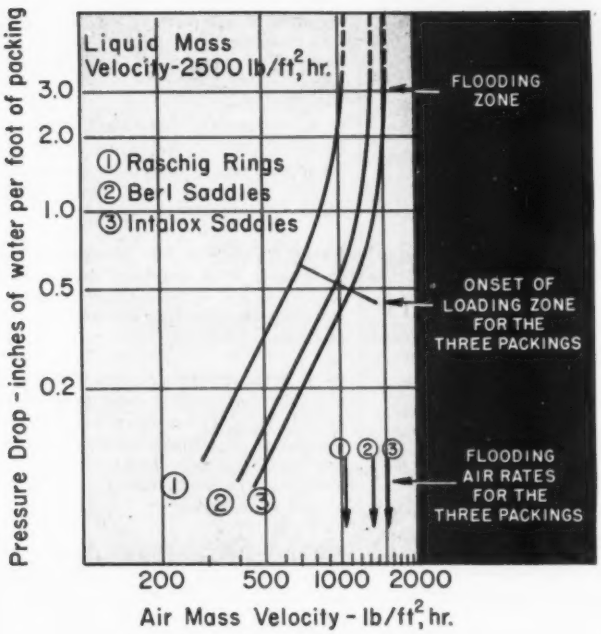
CAMBRIDGE WIRE CLOTH CO. has established a new Middle West sales territory to embrace Colorado, Nebraska, Kansas, Oklahoma, Missouri, Iowa and Arkansas. Operations will be directed by **Andrew J.**

How to increase throughput through your PRESENT packed columns

If your present packed columns are using either Raschig Rings or Berl Saddles you can increase throughput substantially by re-packing your towers with Intalox Saddle packing.

The data in the accompanying chart show typical pressure drop, loading and flooding points for all three packings in the 1" size, all operated under a liquid irrigation rate of 2500 lbs./ft.^{2} hr.

You are ahead with Intalox Saddles in any way you operate your tower. Should you prefer to work substantially below the loading point, say at a gas rate of 500 lbs./ft.^{2} hr., your pressure drop savings as compared to Raschig Rings would be about 65%, and as compared to Berl Saddles, about 25%. Should you wish to operate in the low loading range, as many towers are being operated, you will be able to pass about 50% more gas through the tower, as compared to Raschig Rings; and about 15% more gas as compared to Berl Saddles. And these higher flow rates are realizable at a pressure drop that may actually be lower than you would have with Raschig Rings or Berl Saddles. Of course, the ultimate flooding limits of Intalox Saddles are also higher than for the other packings.



Like to know more about INTALOX SADDLES?

Write for a copy of Bulletin S-29 — full of data every engineer who is concerned with lower cost, more effective packed tower operation needs. Address Dept. PR 459 The U. S. Stoneware Co., Akron 9, Ohio.

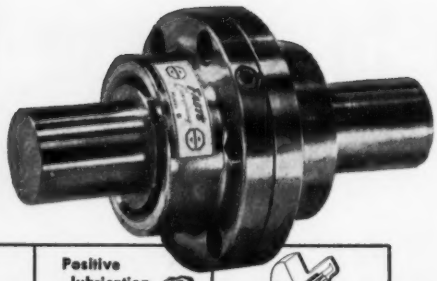
U. S. STONEWARE

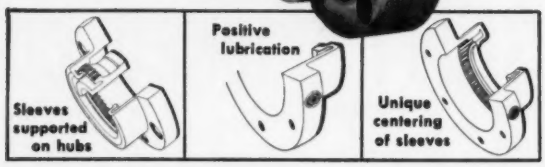
AKRON 9, OHIO

132F

For more data on advertised products, use Readers' Service Cards, last page.

FAST'S Model B Coupling





reduces downtime and upkeep for light-to-medium drives!

Now you can profit from the durability and economy of famous Fast's couplings in a smaller and lower-cost version—available in 5 sizes for shafts ½" to 3⅛" in diameter.

The Model B coupling gives you the same features that have made Fast's the world's leading coupling for over 35 years. You get the same trouble-free performance, longer service life and lower maintenance costs. You also get prompt delivery because stocks are on hand to meet practically every need. Free engineering service is also available.

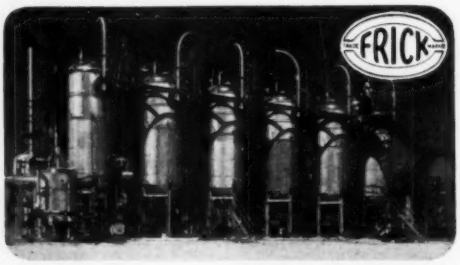
Write today for more details to KOPPERS COMPANY, INC., Fast's Coupling Dept., 6104 Scott Street, Baltimore 3, Maryland.

Engineered Products Sold with *Service*

KOPPERS

THE ORIGINAL *FAST'S Couplings*

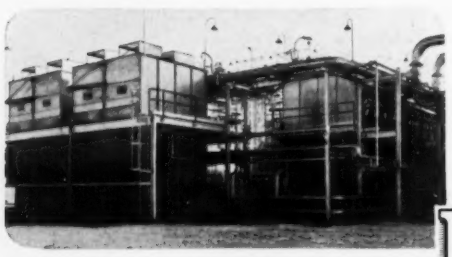
—NEW— GENERAL TIRE AND RUBBER CO. PLANT: Odessa, Texas



Frick Company furnished the twelve big reactors* illustrated, each 22 ft. high and equipped with a double set of Frick cooling coils*; plus coolers and evaporative condensers for butadiene, evaporative condensers for ammonia, and numerous auxiliaries.

Thus another great synthetic plant joins the list of firms using Frick cooling equipment.

Whatever the refrigerating requirements of YOUR plant—air conditioning, process cooling or condensing, cold water, ice making, quick freezing, cold storage, or low temperatures — Frick engineers will help you design a system to meet your needs.



Butadiene condensers at Odessa, Texas

Call your nearest Frick Branch, Distributor or write to.....

* Patented

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA., U.S.A.

Suppliers . . .

Lutz, formerly with the industrial chemicals sales staff, Wyandotte Chemicals Corp. He will headquarter at Kansas City, Mo.

MERRITT-CHAPMAN & SCOTT CORP. has elected **Robert E. Harvey** president. Previously a senior executive vice president, he will have operational responsibility for Merritt's activities. He joined the company in 1954, was elected an executive vice president and a director in 1955, and since 1956 has been senior executive vice president and member of the executive committee. He spent ten years in the shipbuilding and other industrial fields and 15 years with the U.S. government.

Harvey

THE COOPER-BESSEMER CORP. has promoted **Richard L. Spetka** to manager, power engine sales. He will head the sales engineering program on 4-cycle engines for all stationary services.

ALLIS-CHALMERS MANUFACTURING CO.'s Industries group has named **Malcolm S. Jones** manager of the El Paso district. He had been a sales representative in the Denver district since 1951.

B-I-F INDUSTRIES, INC. has appointed Lefler Engineering Sales Co., Billings, Mont., as sales agent for all B-I-F products in the Northern half of Wyoming and Eastern Montana.

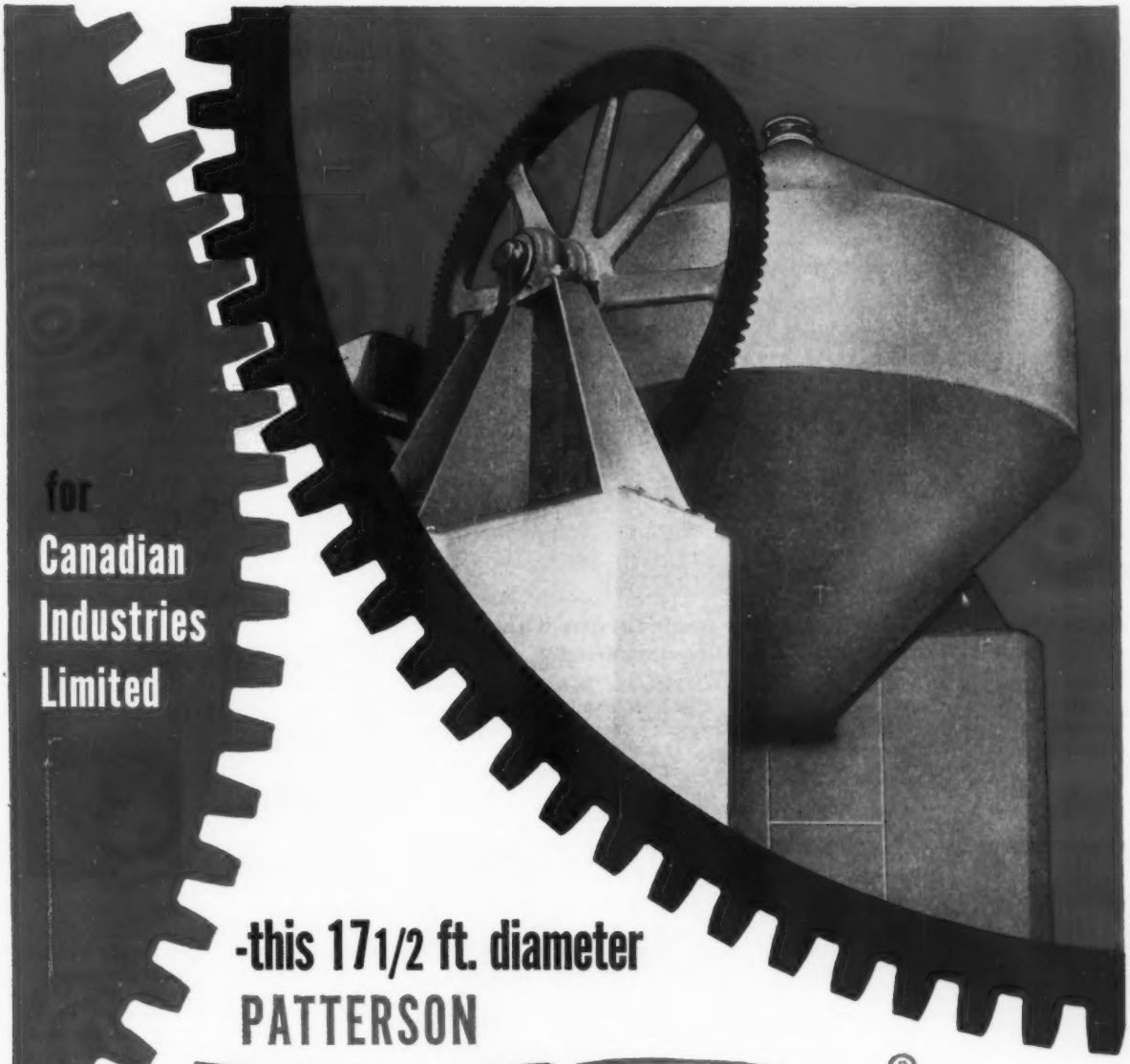
CHASE BRASS & COPPER CO. has promoted **Howard N. Hartman** to district manager, Philadelphia. He graduated from Ohio State University in 1948 and joined Chase in 1952.

U. S. INDUSTRIAL CHEMICALS CO. has established a San Francisco sales office. **Kenneth Fietz,** who will be manager, has been a representative of the New York Sales division for 16 years.

FISHER GOVERNOR CO. has named **Henry J. Ruston** to a company post. He has several years' experience in process instrumentation, having worked in plants at Sarnia, Ont.

U. S. STEEL CORP.'s Supply division has purchased more than two acres of land at Arlington, Texas, for a new office and warehouse. Construction is scheduled to begin within a few weeks on a one-story 39,000-square-foot structure to be completed later this year.

HOOKER CHEMICAL CORP. has named **Charles Y. Cain** assistant sales manager, and **Charles W. Selover** manager of purchases, Eastern Chemical division. Selover will continue as purchasing administrator for the Niagara plant and as



for Canadian Industries Limited

-this 17 1/2 ft. diameter PATTERSON THORO BLENDER®

30-TON batches of polythene pellets perfectly blended in less than one hour

This world's largest conical blender, installed at C. I. L.'s Edmonton Works, takes tons of polythene from storage silos and blends to complete homogeneity in record time. With all surfaces contacting the material of stainless steel, this giant ThoroBlender assures cleanliness of product, typifies PATTERSON know-how in every detail. Do you have an exacting blending requirement? Regardless of scale, from laboratory-size to carload lots, check Patterson!

THE Patterson FOUNDRY AND MACHINE COMPANY
A Division of Ferro Corporation
East Liverpool, Ohio

THE Patterson FOUNDRY AND MACHINE CO. (CANADA) LTD.
Toronto, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

EXCLUSIVELY FOR ALL, or for their larger capacity self propelled rubber tired cranes?

Because, for rugged design and superior performance, the MAXI *has no equal.* **For facts showing you how a one-man operated MAXI mounted self-propelled crane can cut your operating and labor expenses, contact your local crane dealer or write to:**

THE MAXI CORPORATION

902 SOUTH TURNBULL CAÑON ROAD, CITY OF INDUSTRY, CALIFORNIA

MOST MAJOR U.S. PETROLEUM REFINERS REDUCE COSTS with PANALARM ANNUNCIATORS

MAXIMUM INFORMATION on all process variables . . . the result of 10 years system engineering by Panalarm and major petroleum refiners. That's why Universal Series 50 is the petroleum industry's most informative annunciator. Trouble anywhere is signalled instantly—*before* it can grow big and expensive. "Off-normals" are pinpointed instantly, accurately for fast remedial action, reducing costly downtime.

Economical, highly flexible design facilitates system expansion. Can be simply adapted to your exact requirement, avoiding costly custom designing. Proven components—e.g., almost 1,000,000 dependable Panalarm developed relays have been used in Panalarm Annunciators.

Ask your nearby Panalarm sales engineer to show you why Universal Series 50 is the petroleum industry's No. 1 annunciator choice . . . how its adaptability and reliability can help increase your profits . . . by producing maximum information and reducing costly downtime. No obligation, of course.

Write for Catalog 100 B today.

PANALARM®

Division of

PANELLIT, INC.

7401 No. Hamlin Ave., Skokie, Ill.

Suppliers . . .

manager of purchases for the Durez Plastics division plants at North Tonawanda, N. Y., and Kenton, Ohio. His office will remain at Niagara Falls. Cain was formerly assistant general sales manager, Durez Plastics division.

CARLON PRODUCTS CORP., Aurora, Ohio, has named **Thomas W. Kreiner** Southwest regional sales manager. He will locate at the Corsicana, Texas, plant and will supervise the Carlon sales force for Texas, Louisiana, Oklahoma, eastern new Mexico and the mountain states. Kreiner was formerly sales manager of Western Plastics Co., Hastings, Nebr. He was a salesman for Carlon in Nebraska, Kansas and Iowa prior to joining Western five years ago.

Kreiner

Chisholm

Windle

JONES & LAUGHLIN CO.'s Supply division has transferred **J. R. Windle,** salesman at Edmonton, Alta., to Calgary, Alta. **W. J. Chisholm,** former store manager at Drayton Valley, Alta., was named a salesman and transferred to Edmonton, Alta.

NOWERY J. SMITH CO. has named **Lester Sanders** general office manager, Houston. He has a B.B.A. degree from The University of Texas.

FRITZ W. GLITSCH & SONS, INC., Dallas, has established a new sales office in Baton Rouge. **Louis A. Venincasa,** formerly in the Dallas office, has been named representative in charge at Baton Rouge.

ERIE METER SYSTEMS, INC. has become part of A. O. Smith Corporation, Milwaukee. The company will become a part of the new Smith-Erie division.

SINGMASTER & BREYER, INC. has named **James V. Roy** sales manager. A graduate chemical engineer and former sales engineer for Blaw-Knox Co., he was previously a Singmaster & Breyer project engineer.

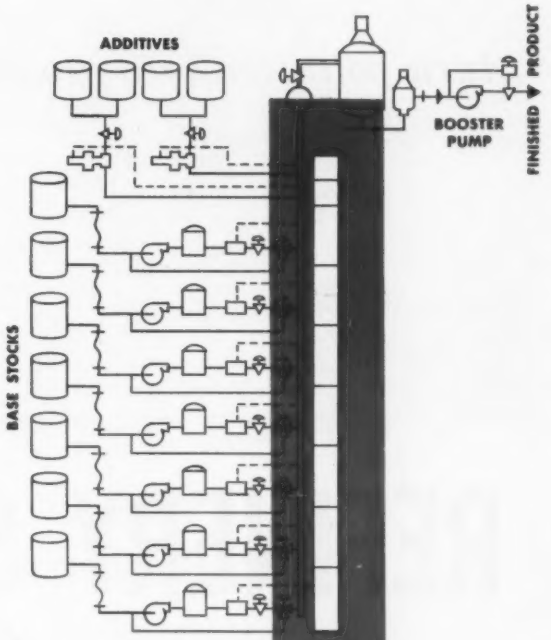
RUSSELL ENGINEERING CORP. has purchased an 8½-acre industrial site in Houston for construction of a metal building to take care of manufacturing

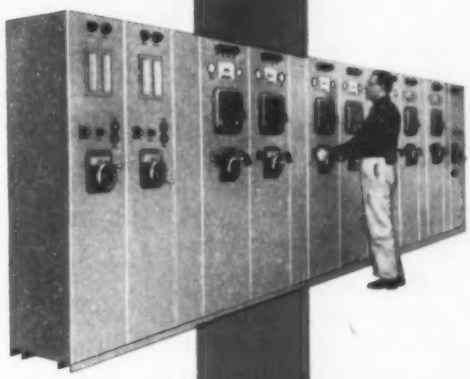
POSITIVE CONTROL OF *MATERIALS IN MOTION* BIF METERS FEEDERS CONTROLS

Mobil

8 REASONS WHY

Magnolia Petroleum's Beaumont Refinery Chose BIF Proportioneers Automatic In-Line Blender!





1. PROVEN DESIGN . . . Proportioneers Automatic Blenders produce over 60% (6,000,000 BPD) of all U.S. finished lube oils.
2. GUARANTEED ACCURACY . . . written guarantee of at least ½% accuracy . . . by volume . . . for *each* component.
3. SINGLE RESPONSIBILITY . . . Proportioneers assumes complete responsibility for design and start-up of tailor-made blending equipment.
4. FIELD SERVICE . . . nationwide organization immediately available for start-up or emergency service.
5. FORMULATION CHECKS . . . recycle loop assures correct component *before* blending starts.
6. INTEGRATED CONTROLS . . . allow all components (base stocks and additives) to be automatically controlled from master computer; totalizers indicate quantities, provide continuous performance and inventory checks.
7. AUTOMATIC BLOWBACK . . . prevents contamination, eliminates slop when base stocks and additives are realigned.
8. SIMPLIFIED MAINTENANCE . . . standard industrial controls used throughout system.

For more lucrative lube blending, request Bulletin SM-2055. Write **B-I-F Industries, Inc., Dept. P, 412 Harris Avenue, Providence 1, R. I.**

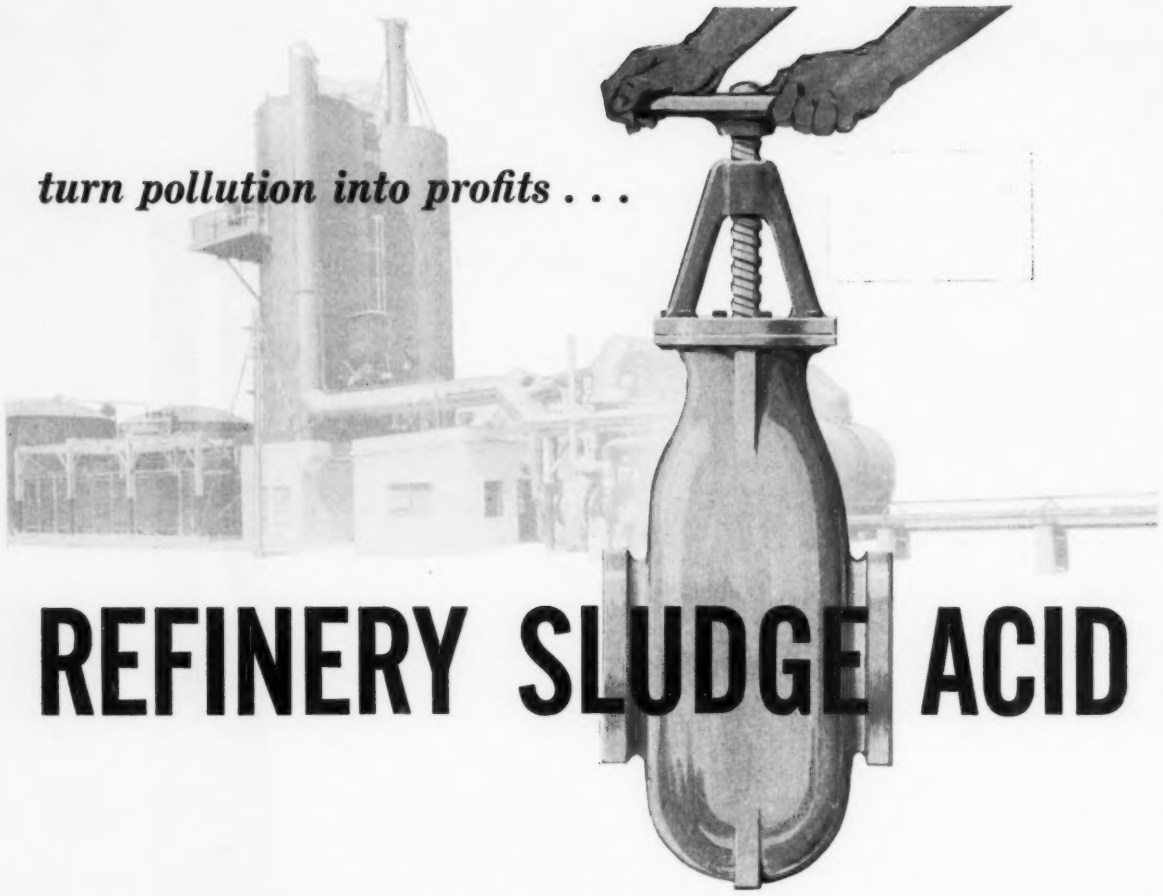
BIF

B-I-F INDUSTRIES

BUILDERS-PROVIDENCE • PROPORTIONEERS • OMEGA

For more data on advertised products, use Readers' Service Cards, last page.

turn pollution into profits . . .



REFINERY SLUDGE ACID

Chemical wealth now buried in refinery sludge acid can be converted into a steady, profitable flow of 98% to 99% clean sulfuric acid. Alkylation spent acid regeneration plants, utilizing the Chemico closed-cycle process, eliminate traditional residue problems. What is not converted back to strong sulfuric acid is used for its heat value. These plants offer automatic operation with low manpower requirements. Since only gases and liquids are handled, operation is clean and plant maintenance costs low.

Today, Chemico-built plants are profitably producing 4000 tons of regenerated sulfuric acid per day – 75% of the U. S. total. In addition, Chemico is now constructing a new regeneration plant which will be the largest single-unit sulfuric acid plant of *any* kind in this country. When you are ready to turn a pollution problem into a profitable operation, Chemico's experience can pay important dividends.

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
525 West 43rd Street, New York 36, New York

CHICAGO • DALLAS • HOUSTON • PORTLAND, ORE. • TORONTO • LONDON • PARIS • JOHANNESBURG • TOKYO

facilities being moved from Colorado. Future plans call for construction of an office building and expansion of manufacturing facilities as required.

WOLVERINE TUBE has named **John B. Harbaugh** technical sales representative in the New York district. A refining engineer graduate of Tulsa University, and formerly with The M. W. Kellogg Co. as process engineer, he will sell to the processing and refining markets. Areas to be covered will include New England, a section of New York City and Northern New Jersey.

Harbaugh

PITTSBURGH COKE & CHEMICAL CO.'s Activated Carbon division, Pittsburgh, has begun a major expansion of its carbon plant capacity. Engineering has been completed and construction is scheduled to start shortly.

COMMONWEALTH SERVICES, INC. has appointed **D. E. O'Connor** and **T. J. Merritt** to the Houston Engineering department. O'Connor will be chief engineer and Merritt will manage industrial engineering.

FISCHER & PORTER CO. has named **Doug Dismukes** water & waste industry manager. He was formerly a field engineer in the Philadelphia office, and has been with the company fifteen years.

SOUTHWESTERN ELECTRONICS CO. has opened SIE's new 300,000-square-foot research, development and manufacturing facility in Houston. It covers 146 acres.

MINNEAPOLIS-HONEYWELL REGULATOR CO.'s Heiland division is expanding its Denver facilities. The program will add 70,000 square feet of engineering, production and administrative facilities.

GENERAL ELECTRIC CO.'s Computer department has named **Dr. David R. Helman** consulting computer engineer, operations analysis, Phoenix. He is an authority on logic design.

OPW CORP. has named **Charles A. Ault III**, district manager, Cincinnati. He has been a sales engineer for OPW since 1957.

LAYNE & BOWLER, INC. has named **C. E. Ponkey** president. He was formerly executive vice president.

LUKENHEIMER CO. has opened a branch in Houston with **William Boles** branch manager. He was previously a sales representative in Baton Rouge.

AMERICAN CYANAMID CO.'s Organic Chemicals division has named **Stephen J. Luscian** southwestern sales representative with headquarters in Los Angeles.

GROVE VALVE AND REGULATOR CO. has named **Jack Huddle** to the sales engineering staff, Odessa, Texas office. He is a graduate of Texas Technological College.

ALLIED CHEMICAL CORP.'s Barrett division has named **John C. MacLeod** assistant to the president in charge of operations, New York. Formerly assistant director of operations for the Solvay Process division, he has been with Allied since 1925.

CROUSE-HINDS has named **Frank M. Egan** assistant procurement manager, Syracuse, N. Y. Egan joined Crouse-Hinds in 1947 in Customer Service department, later becoming manager. In 1957 he became assistant purchasing agent.

ORBIT VALVE CO. has appointed **R. A. Lauducci** chief engineer. He was previously with Midwestern Instruments, Inc., Tulsa, as coordinator of planning for all engineering projects. He has experience with several large corporations in designing automatic plant production and processing equipment and material handling systems. Other work includes rocket engines and servovalves—with engineering research on the latter's operating characteristics. Lau-

Lauducci

ON THE SPOT
for
immediate
delivery

Diethylene Glycol
Triethylene Glycol
Ethanolamines

For removal of water, hydrogen sulfide and carbon dioxide from natural gas streams—local stocks are available for on-time delivery schedules to fit your processing requirements.

In the Southwest, call Ranger Chemical Company, Houston, Texas, or Western Chemical Company, Odessa and Borger, Texas, and Farmington, New Mexico. Tank car, tank truck, and drum shipments are also available from the Brandenburg, Kentucky, plant.

For data sheets, samples and information, see your Olin Mathieson representative or write today.

6566

MATHIESON

OLIN MATHIESON
CHEMICAL CORPORATION
Chemicals Division • 745 Fifth Ave., N. Y. 22, N. Y.

We're Still Looking for a **Pipe Fitter** Who Doesn't Prefer RIDGID®

International Petroleum Exposition
Booths 28-31

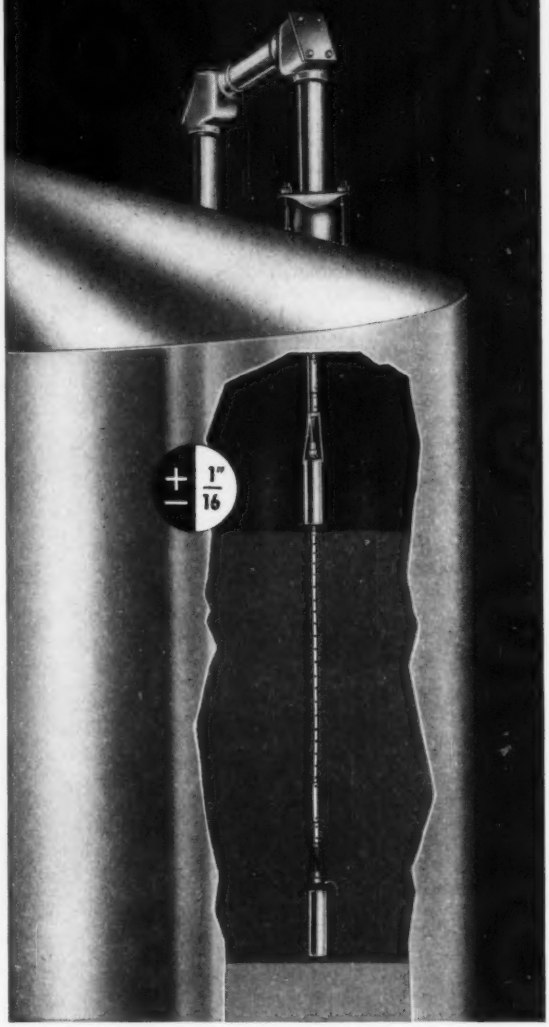
"Of Course I said RIDGID ... It's the only pipe wrench for my money. I've got work to do!"

At your Supply House

The Ridge Tool Company Elyria, Ohio, U.S.A.

THREADED PIPE... *It's Tight... It's Best... Costs Less!*

NOW COMPLETE AUTOMATION IN TANK GAUGING!



You can eliminate hand gauging completely with the new Gilbarco electronic Tank Gauge because this gauge measures *both product level and water interface.* At the turn of a switch the sensing element, which tracks product level, will penetrate the product to also measure water bottom. Readings of both levels can be made at the tank base or remotely on a Gilbarco Null-Balance Receiver. Gauges already installed can be equipped for this dual operation quickly, easily, inexpensively. Write for full information on the *only* gauge which gives you complete gauging automation.

Gilbarco

Gilbert & Barker Manufacturing Co.
West Springfield, Mass.
Toronto, Canada

Suppliers . . .

ducci is a graduate of Syracuse University and has done graduate work at Stevens Institute of Technology and Oklahoma State University.

ALLIS-CHALMERS MANUFACTURING CO.'s Industries group has named **Bruce C. Halsted** manager of the Richmond district. He joined the company in 1941.

JAS. P. MARSH INSTRUMENT CO. has elected **Robert E. Barnett** vice president for sales. He was formerly sales manager, and has been with the company for 18 years. **Joseph T. Carpenter, Jr.,** has been named a sales representative in the Cleveland Office. He attended the U. S. Naval Academy and Northwestern University.

LADISH CO. has established a Dallas sales office. **W. F. Brockwell** and **R. O. Barlen** will represent Ladish there.

FRICK CO., has appointed **David J. Wood** assistant sales manager. He has a B.S. degree in mechanical engineering from Fenn College, Cleveland, Ohio, in 1938.

WALWORTH CO. has appointed **Elo Blomquist** as manager, Plastics division sales. He has been a sales engineer with the company since 1946.

BRADSHAW STEEL & FORGE CO. has been formed by **Ken Bradshaw,** former vice president and general manager of O.T.M. Corp., Houston. He recently resigned his position and sold his interests in that company. Executive offices and plant facilities will be located at Wainwright Shipyard in Panama City, Fla. Bradshaw will continue to operate a branch office in Houston. The company already has appointed several key executives.

Ken Bradshaw

Use Readers' Service Postcard for More Information on Advertised Products

Petroleum Refiner Classified Ads

Petroleum Refiner New Classified Rates

RATES: Regular Classified (undisplayed) set in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

* * * * * * * * * * * * * * * *

FOR SALE

Specify SAUEREISEN
ACIDPROOF CEMENTS—COMPOUNDS
FOR
Tanks, Sewers, Stacks, Floors
Technical cements for all purposes.
Send sketches or samples
Sauereisen Cements Company · Pittsburgh 15, Penna

When you see a large chimney think of Sauereisen Cements.

2 OLIVER PRESSURE PRECOAT FILTERS
TYPE 316 S.S. VERY FINE CONDITION
MACHINECRAFT CORPORATION
800 WILSON AVE., NEWARK 5, N. J.
MITCHELL 2-7634

FLOW INDICATORS
All sizes up to 6"
SEND FOR CATALOG
ERNST
Water Column & Gage Co.
LIVINGSTON, N. J.
CYLINDER
DOUBLE WINDOW

■ CLEANING EQUIPMENT—for plant maintenance and tank cleaning. Hot "jet-stream" cleaning with Sellers Hydraulic Jets. Send for Bulletin 424-B Sellers Injector Corp., 1603-L Hamilton Street, Philadelphia 30, Pa.

SITUATION WANTED

■ Chemical Engineer—1949: Nine years diversified experience including design/development with petro-chemical company, project/process engineering with engineering contractor, last 4 years technical service (process) engineer with refinery. Good references. Desire Southwest/Rocky Mountain location in similar work or technical sales. Resume on request. Box 315-R, Petroleum Refiner, Houston 1, Texas.

■ Instrument-Electrician. 11 years experience on all types of instruments used in the Refining Industry. Conscientious, hard working. Desires position to use experience and a better future. Reply Box 214-R, PETROLEUM REFINER, Houston, Texas.

■ Chemical Engineer—Five years experience in petroleum refining. Good background in refining problems and processes. Some computer experience. Desire position in Southwest. Box 316-R, PETROLEUM REFINER, Houston, Texas.

HELP WANTED

PETROLEUM REFINERY CHEMICAL ENGINEERS APPLIED MATHEMATICIANS

For expanding technical activity engaged in consulting-type service to petroleum refiners. Positions involve a wide variety of projects in sales, research, refining, and company management. Excellent opportunities for persons with either or both of the following backgrounds:

A few years of refining industry experience in process engineering or economic analysis.

Experience in applications of linear programming, statistics, or electronic computing.

These positions afford professional contact with refining and process companies throughout the petroleum industry, and provide opportunity for using initiative and individual expression to increase responsibility. Detroit suburban location.

Send resume to:

Personnel Manager
ETHYL CORPORATION
1600 W. 8 Mile Road Ferndale 20, Michigan

INSTRUMENT ENGINEER

Excellent opportunity for a man experienced in instrumentation to join engineering staff of a new chemical plant located in Southwest.

Position duties include applications, maintenance, and modification of automatic control instrumentation in chemical process plant.

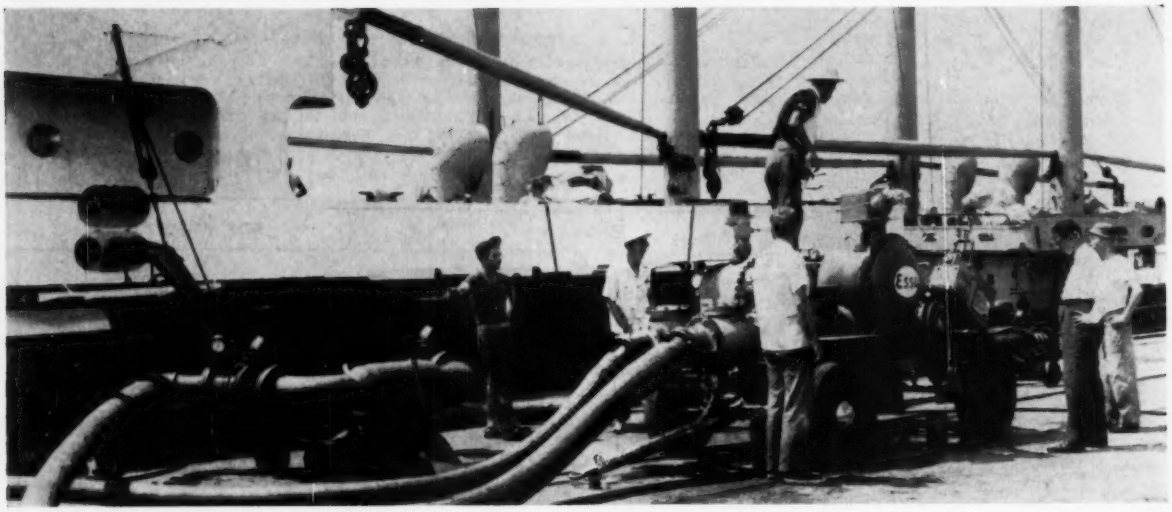
Applicants should have degree in Electrical, Chemical, or Mechanical Engineering, with 3 to 5 years experience in process control instrumentation in chemical, petro-chemical, or refining industries.

Submit resume to Professional Employment Manager.

U. S. INDUSTRIAL CHEMICALS CO.
Division of
NATIONAL DISTILLERS and CHEMICAL CORP.
99 Park Avenue New York 16, N. Y.

WANTED

■ PETROLEUM REFINER back issues and files wanted to buy for cash, also other technical journals. P. R. Ashley, 27 East 21, New York 10, N. Y.



Mobile Bunkering Blender Is Versatile

Fuel blender needs no outside power supply, can be used as portable or permanent installation

A versatile Mobile Bunkering Blender for dockside use has just been introduced. The fuel blender needs no outside power supply, but is operated by a pressure differential between the residual and distillate fuels being blended.

Either portable or mounted on skids for permanent or semi-permanent installations, the blender is the economical solution to continuous and automatic on-the-spot stream blending directly to the ship from base stock storage tanks. There is no need to store a great inventory of fuels of different viscosities—hundreds of finished blends—in countless storage tanks. Short notices of two or three hours need not cause undue concern.

The blender has provision for automatic shutoff in event of failure of one of the streams. It follows varying flow conditions, regulating itself without upsetting the preset percentage of residual and distillate. Adjustment is from 90 percent residual and 10 percent distillate to 50 percent residual and 50 percent distillate fuel.

The blender contains two positive displacement meters, one for measuring residual and the other for distillate fuels. These are linked together through an adjustable variator and mechanical differential which operates the blender and stops all pumping action should either line stop. Because each stream contains its own totalizer, inventory checks can be made on the spot at any time.

Maximum operating pressure of the Mobile Bunkering Blender is 300 psig, 30 kilograms per square centimeter. Standard design allows for capacities of 2,100 GPM U.S., or 1710 GPM Imperial—480 cubic meters per hour. Higher capacities are available on request. B-I-F Industries, Inc.

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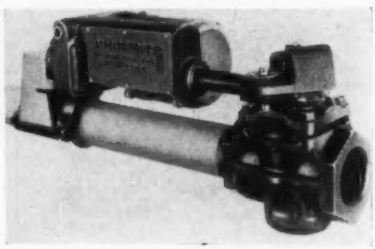
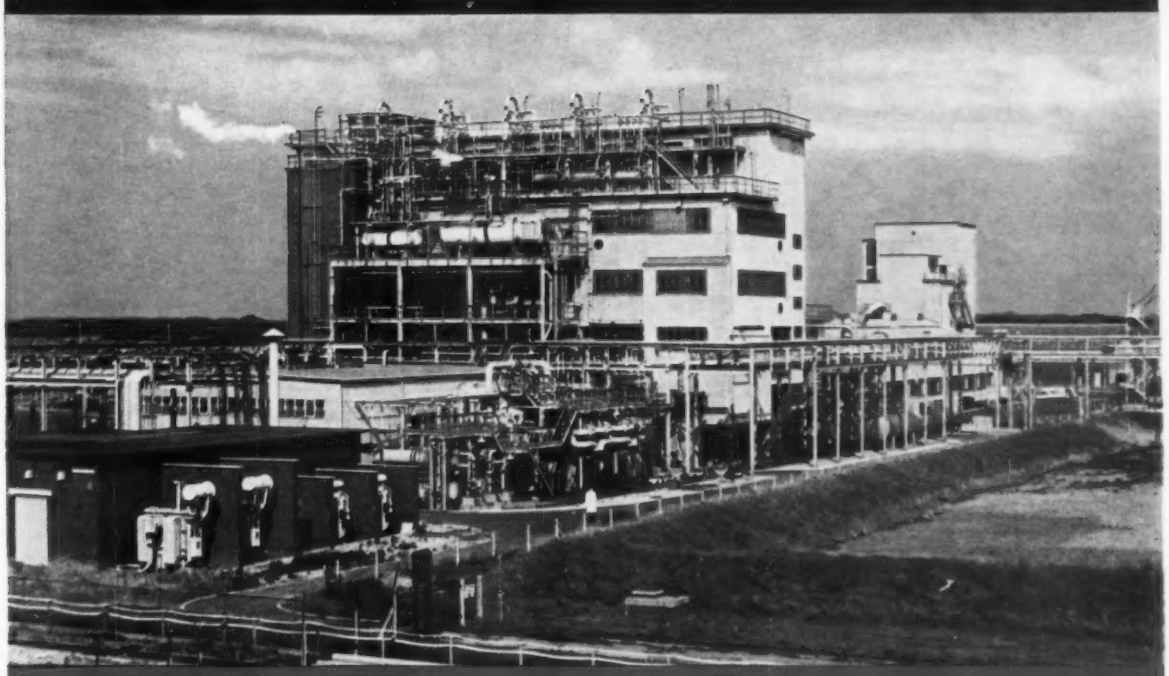


Av-Gas Corrosion Inhibitor Permits Very Low Dosage

A new corrosion inhibitor for use in aviation gasolines is available to be marketed as AFA-1 Aviation Fuel Additive, it is expected to find widespread application in aviation gasolines because of its high effectiveness at low dosages.

STONE & WEBSTER IN GREAT BRITAIN

New Flexibility in Chemical Production



Designed for the greatest flexibility consistent with efficient operation, the new Imperial Chemical Industries Limited plant at Wilton, England, currently produces an unusually wide range of copolymers from butadiene and three other monomers. Facilities provide for taking the product as latex, baled crumb or as powder.

The extensive experience of the Stone & Webster organization in design and construction of synthetic rubber facilities during and since World War II was fully utilized in the planning of this versatile British installation. Chemical processes for the new plant were developed by I. C. I., while final designs and actual construction were carried out by Stone & Webster Engineering Limited of London.

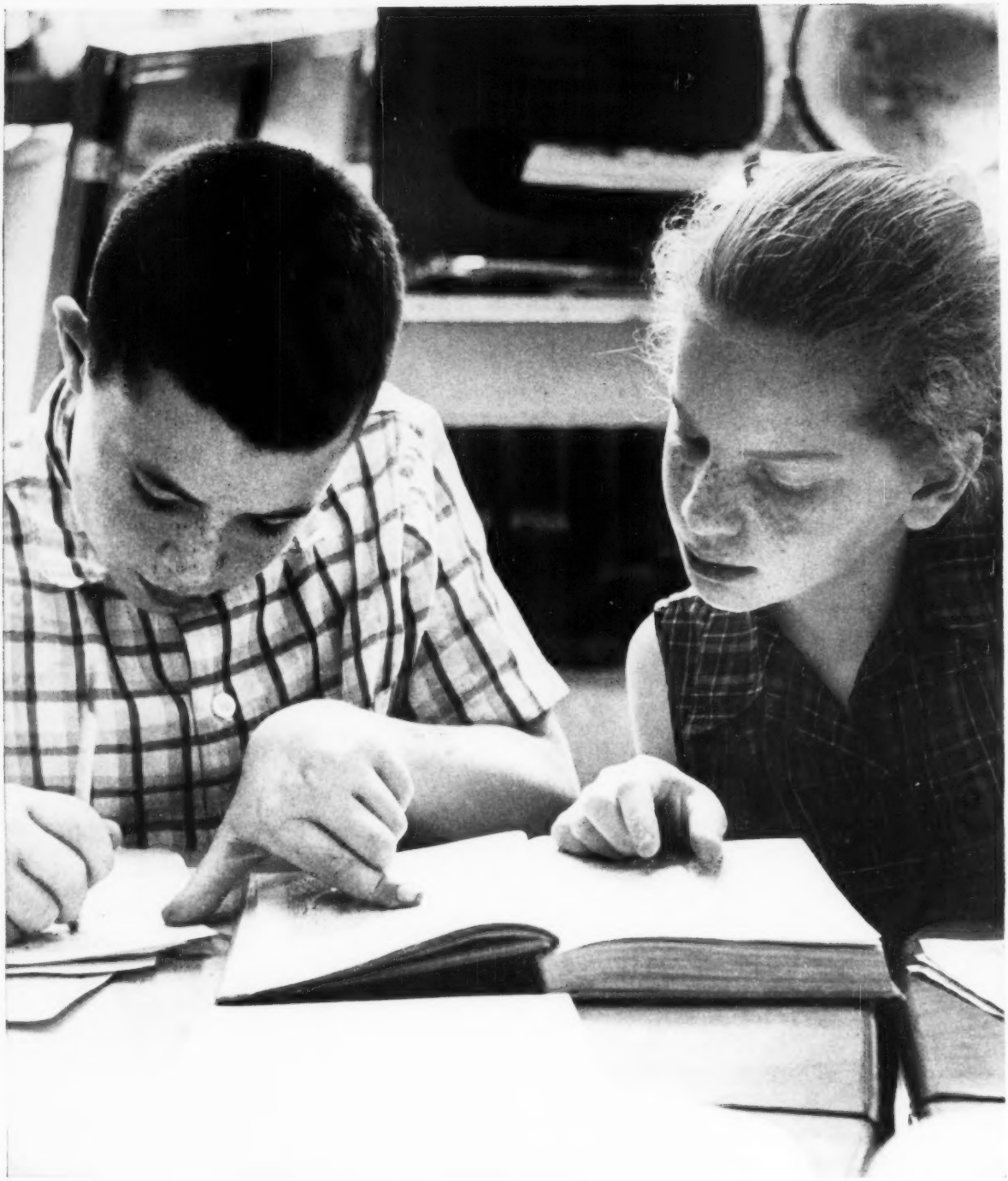
Let the skill and experience of Stone & Webster engineers assist you on your next engineering project. Call our nearest office.

Stone & Webster adds profits to your project through engineering economies and plant efficiency.

STONE & WEBSTER
ENGINEERING CORPORATION

Affiliated with STONE & WEBSTER ENGINEERING LIMITED (London)

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto



"Nowhere is the need for knowledge about business more important than among America's young people . . . It is striking that they know so little through their formal education about the economic system which enabled them to go to school, in which most of them will work, and through which all of them will be supported at their graduation." —M. J. Rathbone, President

Esso

Standard Oil Company (New Jersey)
and affiliated companies

For more data on advertised products, use Readers' Service Cards, last page.

As little as four pounds per 1,000 barrels effectively prevents corrosion, according to the manufacturer's tests.

Containing about 5.3 percent phosphorus by weight, the AFA-1 additive has an extremely low ash content and is effective in many types of finished products and refinery stocks. Petroleum Chemicals Div., E. I. du Pont de Nemours & Co., Inc.

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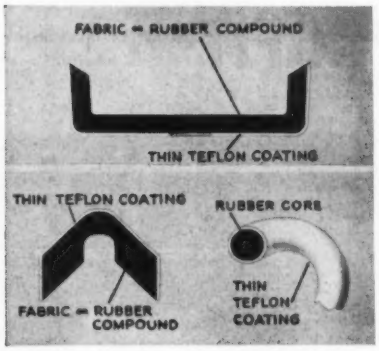

Teflon Coated Cups Cut Cylinder Friction

The development of Teflon-coated cups for use in hydraulic and pneumatic equipment will substantially improve operation of equipment using this type of packing.

The cups reduce the breakaway torque required to operate cylinders, reduce running friction, will not stick to cylinder walls even after prolonged periods of idleness, and eliminate packing chatter and squealing. These advantages extend packing life considerably and greatly reduce down time.

Teflon, with its low coefficient of friction and antiadhesive characteristics, has for many years resisted efforts to use it as a coating. A technique has been perfected which overcomes Teflon antisticking qualities. A thin layer of Teflon coats and cups and this coating becomes an integral part of the packing. Cost of the new cups is low, only slightly more than ordinary cups. The Garlock Packing Co.

Circle E3 green card, last page

Seal Works On Stuffing Boxes Too Hot To Handle

A new bulletin just off the press, illustrates and describes a mechanical seal development for pumps handling water or light hydrocarbons in the higher temperatures.

This Dura-designed Circulating Seal for hot liquids is really a pump within a pump, circulating liquid from a stuffing box through a heat exchanger and returning it to the stuffing box at a reduced temperature. Durametallic Corp.

Circle E4 green card, last page

Manual Starters Can Be Locked In Off Position

A unique new "lock-off" device has been incorporated in NEMA 4 and NEMA 12 enclosures for manual starters. By sliding a stainless steel plate over the "start" button and inserting a padlock, the starter can be locked in the "off" position. The pushbuttons are recessed to prevent accidental operation.

The new NEMA 4 watertight and NEMA 12 industrial enclosures are designed for the manufacturer's types B and C integral-horsepower manual starters. Silicon rubber boots over the pushbuttons prevent the entry of water, dust, or coolant. The "start" and "stop-reset" buttons are made of anodized aluminum, and are inserted in the boots. Square D Co.

Circle E5 green card, last page

Ball Valve Can Be Mated To Four Different Flanges

A four-in-one Econ-O-Miser flange ball valve has been developed. Here is one unit that will serve as either a 150 or 300 pound valve where conditions need

NOW!

Wipe out Weeds and Brush

for as long as ***8*** *to* ***18*** *months*

with one application of UROX®

Now you can wipe out troublesome weeds and brush faster, easier, at lower cost and for a longer time with just one application of Allied Chemical's UROX Weed Killer.

This powerful herbicide effectively handles weed killing jobs on tank farms, around refineries and pumping stations, and along pipelines. It destroys weeds and brush in non-crop areas wherever they form a fire hazard, an eyesore or a maintenance problem.

Longer lasting! Saves time and money! UROX tends to build up increasing soil sterility. Its herbicidal action can thus be extended from one year to the next with light booster doses. As smaller and smaller amounts are used over a period of time, you realize substantial savings.

Get the whole story! Send today for our new full-color UROX folder, "Candidly Speaking." You'll see unretouched candid camera evidence of UROX's effectiveness in many widely-separated geographical areas, many different climatic conditions. These actual photos from the field tell the UROX story with greater accuracy than words can convey.

To obtain your free copy of the new UROX folder, "Candidly Speaking," mail the coupon.

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

Weed Killer Dept. PR-49
GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL CORPORATION
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Please send free copy of the new UROX folder, "Candidly Speaking."

Name _____
Title _____
Company _____
Address _____
City _____ Zone _____ State _____

For more data on advertised products, use Readers' Service Cards, last page.

GET CLOSER CONTROL OF YOUR NATURAL GASOLINE PROCESS —ASSURE MAXIMUM PROFIT

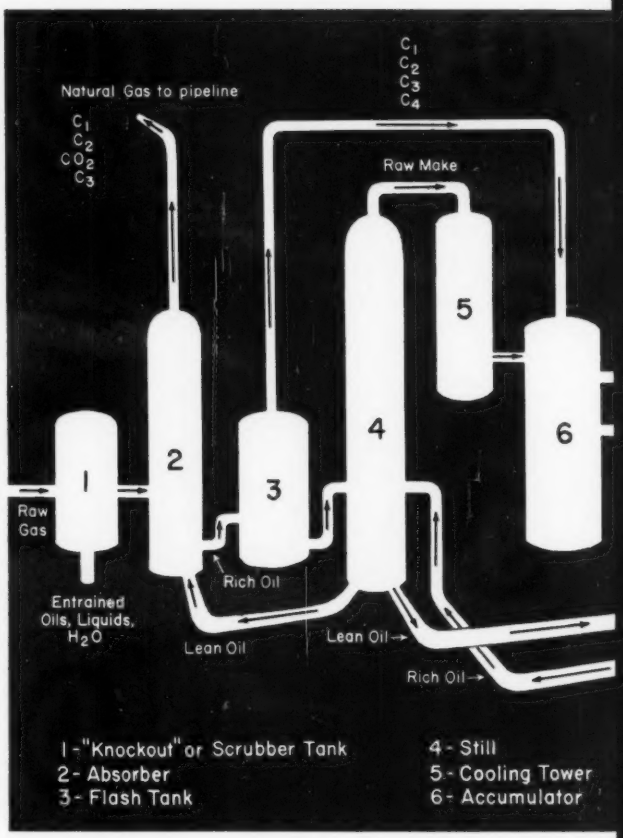
Perkin-Elmer process vapor fractometer automatically signals variations in stream composition

Continuous, reliable, *automatic* process control is a form of profit insurance. Nowhere is this better illustrated than in natural gasoline plants, where any non-uniformity of the process stream usually goes directly into the pipeline and on to the customer.

The new Model 184 Process Vapor Fractometer employs the simplicity and reliability of gas chromatography to provide automatic multi-component monitoring of process streams. The instrument is designed to handle a wide range of gases and light liquids in chemical and petroleum streams.

Developed by Perkin-Elmer with the cooperation of several major oil companies, the Model 184 has been thoroughly field-tested in refinery, petrochemical and natural gasoline applications. Immediate advantages are its low cost*, easy installation, simplicity of operation and maintenance.

The next page shows how the Model 184 Process Vapor Fractometer prevents loss or degrading of product in a typical natural gasoline plant. P-E engineers will be glad to show you how this instrument can improve and then maintain the efficiency of *your* processing operation.



How the process vapor fractometer monitors a natural gasoline stream

In a typical natural gasoline plant processing 300 million cu. ft. of raw inlet gas daily, even minute variations in stream composition can erode profits from two sides. On the one hand are the profit losses that result when a product exceeds specifications in a costly component; on the other, the out-of-pocket losses incurred when the product must be reprocessed or downgraded.

In a natural gas plant there are at least three vital control points where continuous automatic analysis with the Model 184 pays off handsomely:

Deethanizer Bottoms – to cut C_2 and C_3+ fractions with near maximum allowable ethane going to the propane product.

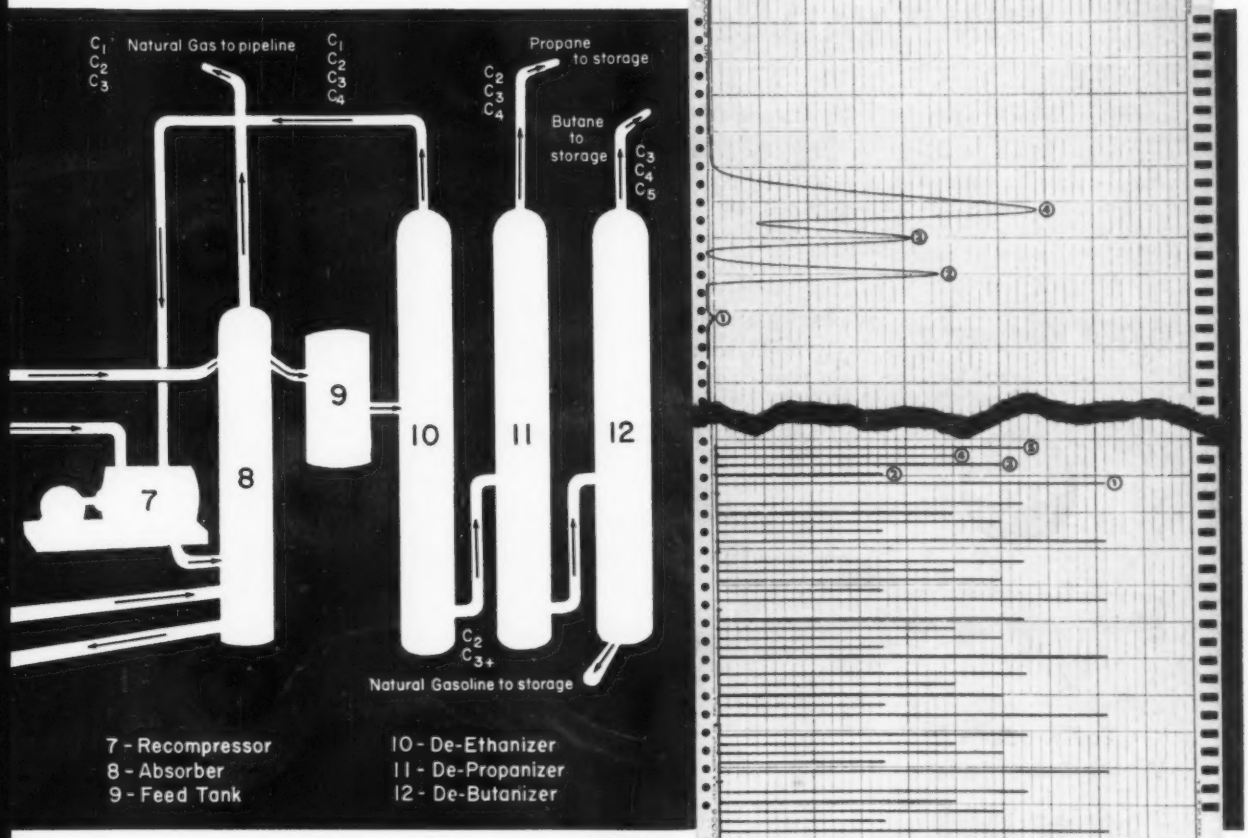
Depropanizer Overhead – to meet, without exceeding, minimum purity of propane spec. In a typical plant, inclusion of 4% ethane can save $16,000 a year at current propane-ethane price differential.

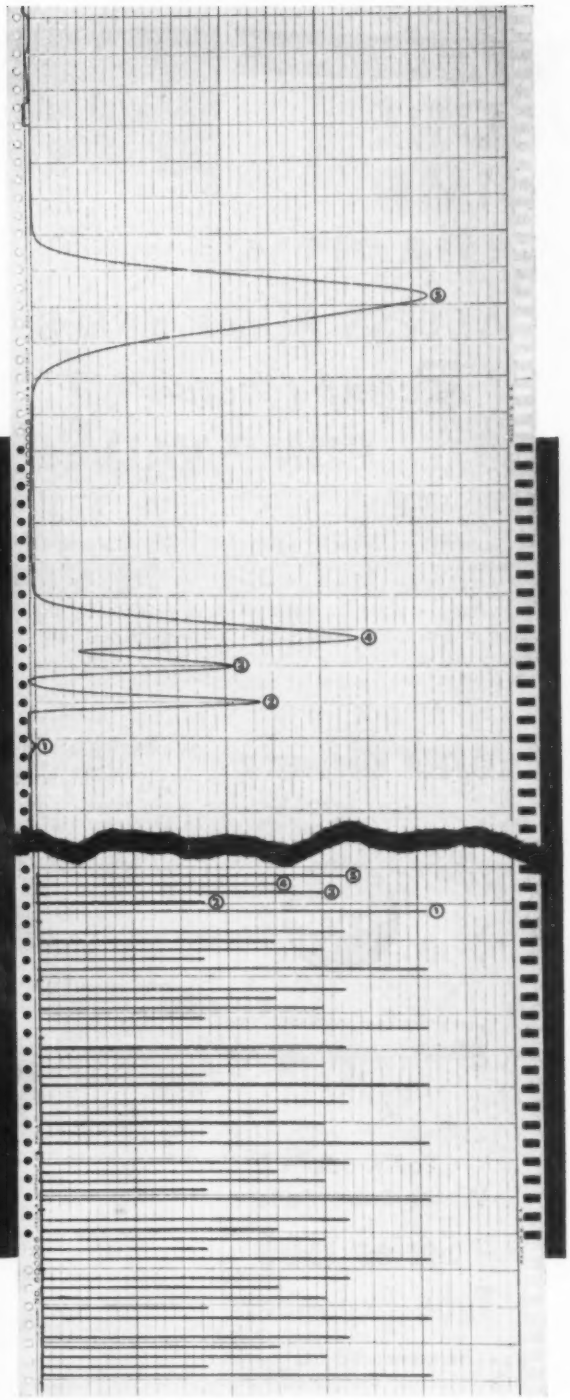
Debutanizer Overhead – to monitor butane product purity, allowing for maximum gasoline volume. Even in a plant of modest size, one hour of below-spec production here can mean reprocessing over 1,600 gallons of product.

*Price $4,950, subject to change without notice.

Fractogram of "raw make" sample (top section, right) illustrates separations attainable on complex hydrocarbon mixtures. Components of interest at this point are (1) C_2, (2) C_3, (3) iC_4 and (4) nC_4. Reverse-flow arrangement (a unique P-E feature) permits C_5+ content to be analyzed as a single peak (5).

Recorder readout mode is bar chart (bottom section), based on fractogram. Peaks have been variously attenuated for optimum display.





Perkin-Elmer Model 184 Process Vapor Fractometer. Left to right: programmer, analyzer, recorder.

The Model 184 can monitor the process stream at other points—wherever continuous automatic analysis will help to stop profit leaks and maintain product uniformity. Furthermore, this versatile instrument can be used as a general trouble-shooter for analyzing any gasoline plant products.

A new brochure, "Automatic Plant Stream Analysis," describes this new instrument system and typical applications where it contributes to process efficiency. Write for your copy to Perkin-Elmer Corp., 880 Main Avenue, Norwalk, Conn.

INSTRUMENT DIVISION
Perkin-Elmer *Corporation*
NORWALK, CONNECTICUT

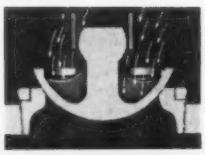
For more data on advertised products, use Readers' Service Cards, last page.

For reciprocating pumps

MORE PUMP CAPACITY ...AT LESS PUMP SPEED with Royal Crown PUMP VALVES

Round valve surface is streamlined. No crossbars or obstructions in seat to restrict the flow of liquid.

Ball-guided valve rotates and swings with each stroke of the pump. Each turn, each swing a lapping action — a continuing perfect seat.



Free vertical action assures instant opening and closing. Ball stem is a frictionless guide.

It's a fact. This revolutionary valve increases pump volume with *less pump speed!* Here's how the Royal Crown Valve operates: Valve is guided by a frictionless ball stem (not a rigid guide) which allows it to oscillate and turn freely with the fluid stream with a minimum of resistance. This means you can pump a greater volume at a slower pump speed for maximum pump efficiency and economy. Royal Crown Valves have only three separate parts which assures long, trouble-free service. They are adaptable to all reciprocating pumps and all liquids.

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The Pump Valve with 1000 Seats

EACH TURN
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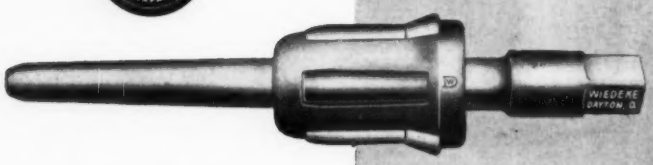

For modern Water Tube Boilers

Series 1500 Tube Expanders

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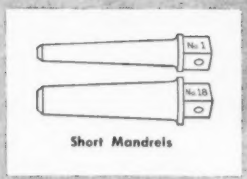
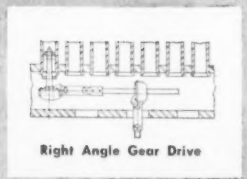
Right Angle Drive speeds-up rolling operation of any Tube inside round or square Header.

See your Dealer or write us for Bulletin.



Short Mandrels



Right Angle Gear Drive

THE GUSTAV WIEDEKE COMPANY
DAYTON 1, OHIO

Equipment . . .

not be answered by a valve of ASA dimensions. Should ASA dimensions be required, this same center section, with the simple addition of an appropriate "spacer" becomes either a 150 or 300 pound ASA valve. Ideal for limited space applications, the center section of the valve is inserted between two standard flanges, either 150 or 300 pound, and the flanges are bolted together.

Because of the various combinations of seats, O-Rings, and body materials available, the company feels that this new unit will accommodate almost any media within the pressure-temperature limitations of the sealing materials. Worchester Valve Co. **Circle E6 green card, last page**

Impact Tool Delivers 850 Impacts Per Minute

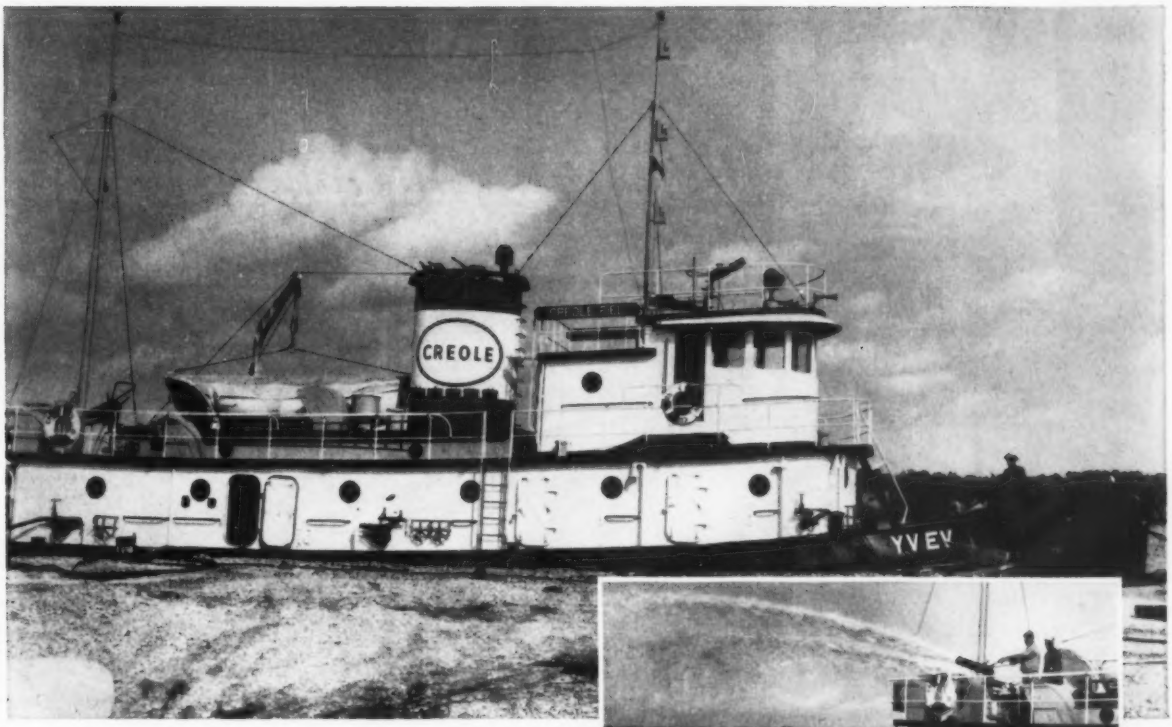
Completely new in design and construction, the size-834 air-powered Impactool has been developed to give 25 percent more power and to run down nuts and bolts 5 times faster than before. The extra power and speed are due to the new direct drive between motor and hammer which takes full advantage of the inertia of rotating parts.

The impact mechanism operates without transmitting any kick or twist to the operator, and even rusted, corroded, or frozen nuts can be removed simply by flicking the reverse switch. A vane-type motor is used for long-life performance. Exhaust noise is muffled without any loss in power.

The new Impactool spins down nuts with a free speed of 3,500 rpm, and delivers 850 powerful impacts per minute. The tool weighs 19⅞ pounds (less socket), has a length of 13$\frac{1}{16}$ inches measured to the shoulder of the square driver, and a side to center distance of 2$\frac{1}{16}$ inches. It is rated to run bolts up to 1¼-inch thread size and has a 1-inch standard square driver. It operates from ¾-inch air hose and has a hose connection pipe tap of ⅜-inch. Ingersoll-Rand Co. **Circle E7 green card, last page**

Computer Designed For Process Control

The 312 Control Computer System is the newest member of the company's computer family. It was designed especially for process control, data logging and data processing requirements. In on-line operation it can be coupled to process instrumentation, thereby becoming the key link of a data system for the acquisition, processing and monitoring of process data as well as for control of the process itself. In off-line operation it can receive process parameters and variables



One of four dual-purpose tugboats operated by the Creole Oil Company in the Lake Maracaibo area, Venezuela. Larger photo shows some of the Rockwood fire-fighting equipment, including a turret nozzle above the pilot house, partial view of two turret nozzles on the after part of the boat deck, and three of six hose stations on the main deck. Smaller photo shows the two turret nozzles on the boat deck throwing a solid stream of Rockwood FOAM.

Tugboat doubles as a powerful fireboat

Rockwood FOAM system adds valuable protection against fire damage, afloat or ashore

Besides their daily value in towing jobs, Creole Oil Company tugboats have considerable emergency value. With their Rockwood automatic FOAM systems they can fight the toughest fires with the most modern equipment.

Each vessel carries 1500 gallons of Double-Strength FOAM, from which 400,000 gallons of expanded FOAM can be generated. Using expanded FOAM at maximum output, the automatic system can operate for 30 minutes.

The three Rockwood turret nozzles, one on the pilot house and two on the after boat deck, are under direct manual control. The three hose stations shown are duplicated on the other side of the vessel. Rockwood discharge equipment includes four 1½" SG-60 nozzles with FF extension units, four 2½" FFF nozzles and two 10' and 12' low-velocity extension applicators.

Rockwood automatic controls enable discharge of FOAM or water, separately or in desired proportions, from all turrets and stations. With controls set . . . starting the pumps for FOAM and water is all that's necessary to assure fast, trouble-free operation and to free all hands for other fire-fighting duties. In addition, the Double-Strength FOAM aboard can be quickly fed into on-shore piping or hose systems, for fighting fires too far inland from the tugboat.

Protective advantages like these are typical of Rockwood systems and products on ships, land vehicles or stations. Tested and listed by Underwriters' Laboratories, Inc. Send coupon for details.

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Engineers Water . . . to Cut Fire Losses

Distributors in all principal cities

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Please send me details on Balanced Pressure Proportioning System and Double-Strength FOAM liquid.

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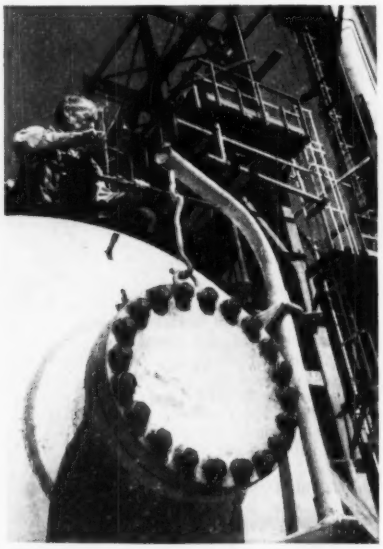

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ELIMINATE CORROSION PROBLEMS in a wide variety of oil and natural gas handling applications with Republic Plastic Pipe. Republic produces a complete range of sizes in SRK (A.B.S. Material), SRB (Semi-Rigid Butyrate). Easy to use. Send coupon.

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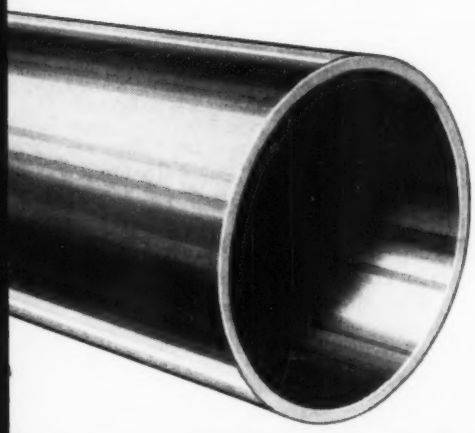
. . . exclusive with Republic ***ELECTRUNITE*** *Heat Exchanger Tubing*

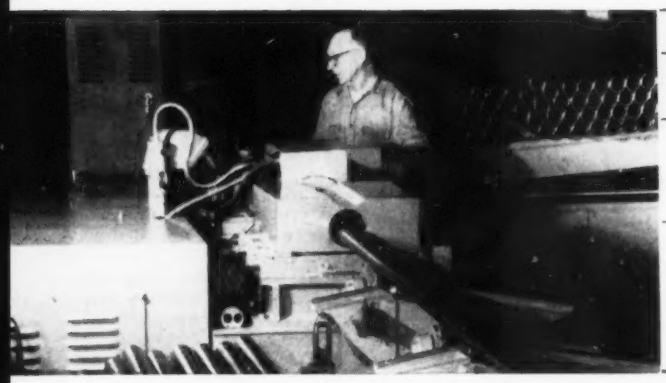
. . . Carbon and Stainless Steel. FARROWTESTED tubes have passed the most searching test of all, a non-destructive eddy-current test that probes for and detects injurious defects. On a production basis, the magic eye of FARROWTEST looks deep within the tube wall, is calibrated to reject tube with defects as shown in the table below. Defects that pass internal fluid or gas pressure tests, which cause a premature failure.



FARROWTEST® is offered as an alternate to other less positive tests at no increase in cost! Carbon steels produced to ASTM specification A-214; stainless steels to A-249. Both include eddy-current test requirements.

As a tube buyer and user, you owe it to yourself and your company to get the facts firsthand. ELECTRUNITE® Heat Exchanger Tubes are being production tested on FARROWTEST equipment every day. It is there for you to see. Additionally, Republic has performed "autopsies" on all types of tube which FARROWTEST has rejected. The hidden defects are there for you to inspect at our Cleveland mill.

Specify FARROWTESTED Republic ELECTRUNITE Heat Exchanger Tubes and get *quality you can measure.* Call Republic or send coupon.



FARROWTEST REJECT TABLE

Wall Thickness (B.W. Gage)	Minor dimension of the defect (Length or Depth)	Defective Area (Length X Depth Plane)
20	.006"	.0025 sq. inches
18	.006"	.003 sq. inches
16	12½% of wall	.003 sq. inches
14 and 13	12½% of wall	.004 sq. inches
12 and heavier	12½% of wall	.005 sq. inches

FARROWTEST detects and rejects not only tubing containing defects which completely penetrate the wall; but also tubing with defects equal to, or greater than, those shown in this table. For irregular defect shapes, a tube with defect area equal to or greater than shown above is rejectable. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.

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Equipment . . .

and perform the necessary calculations to optimize the system.

The 310 Data Acquisition System for Process Monitoring uses both analog and digital components, as required. Continuously varying inputs from such devices as thermocouples are converted to digital form and tallied. The system uses automatic scanning, independently variable. An automatic typewriter prints out process data as well as manually entered information.

The system provides accurate information for process control, quality control, inventory control, and cost control. Extreme reliability (all transistorized circuits, heavy cabinets, etc.) is stressed. Automatic high-low alarm, print-out in corrected engineering units, and many other features are incorporated. Advance bulletins on these computers are now available. General Electric Co.

Circle E8 green card, last page

Single Basket Strainer Has Low Flow Resistance

A line of newly-designed, single-basket pipe line strainers has been developed. Minimum flow resistance, simplicity, quick cleaning, and economy are features of these strainers.

They are carried in stock, for prompt shipment, in 2, 2½, 3, 4 and 6-inch sizes, all with flanged connections. The rating is 125 psig working pressure (cold). Cast iron is used for bodies and covers. A ductile iron quick-opening cover clamp is provided on all sizes except the 6-inch, which has a bolted-on cover.

Standard basket construction is stainless steel plate with ⅛-inch perforations. The ratio of basket free area to cross-sectional flow area of the strainer connections is five to one. For fine straining, baskets are available lined with fine mesh stainless steel screens, in which case the support baskets have ¼-inch holes.

Sealing of the basket to the strainer body is accomplished with compressive force applied by the body cover through the basket handle. Schutte and Koerting Co.

Circle E9 green card, last page

How Bi-Metal Tubes Stop Corrosion Told In Brochure

"Solving Corrosion Problems in Industry" is a new 24-page brochure explaining how Duplex Tubes help solve corrosion problems in condenser and heat exchanger equipment in petroleum refineries, chemical and petrochemical plants.

The bi-metal tubes are designed to provide maximum corrosion resistance in condensers and heat exchangers where

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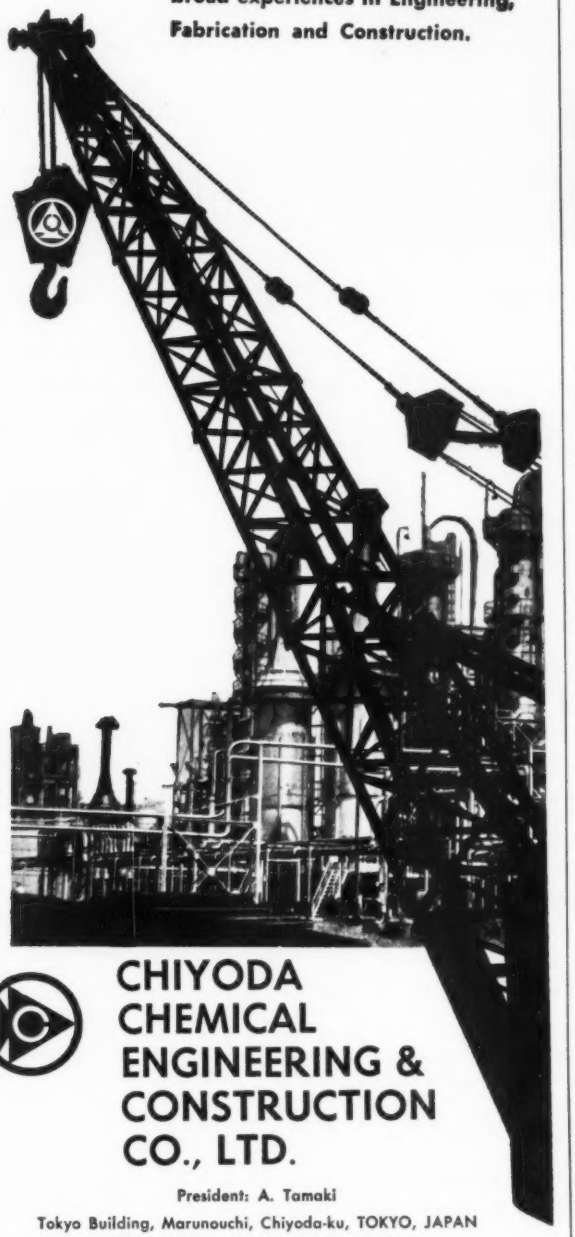
Your plant engineering, fabrication and Construction probrems in Chemical, Petroleum, Petrochemical and nuclear fields..... will be solved by CHIYODA's broad experiences in Engineering, Fabrication and Construction.



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President: A. Tamaki
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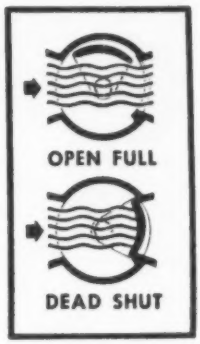
NO OTHER VALVE can give you the advantages of DeZurik's EXCLUSIVE Eccentric Action in combination with resilient-faced plugs. NO OTHER VALVE can give you **tighter shut-off—easier operation—WITHOUT LUBRICATION!**

DeZurik's exclusive eccentric action pivots the plug eccentrically, matching an eccentrically-raised seat. The plug touches the body **only** when the valve is shut. In opening the valve, the plug backs away from the seat and swings aside in an easy quarter turn . . . without friction, without binding, WITHOUT LUBRICATION!



FOR SO MANY refinery applications, DeZurik Valves offer so much more: top efficiency, minimum maintenance, longer life. They're available in sizes ½" thru 20" in many metals and models with a full range of operators. Why not see for yourself? See the DeZurik representative in your area or write

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New BEVELED ORIFICE®

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feature for feature are SUPERIOR

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Designed to join sections of pipe and at the same time measure or control the flow of liquids and gases under pressure at high or low temperatures, this new BEVELED ORIFICE® Union introduced by Clayton Mark finds application in chemical processing plants, oil production facilities, utility power plants, atomic installations and countless other industries.

The union is equipped with a one-piece, stainless steel disc shaped to fit the contour of the seats (ball to cone), thus eliminating the need for gaskets. It is also easy to install on both horizontal and vertical lines.

At leading Industrial Distributors in all 49 states.

These carbon steel unions are available in all sizes from ¼" to 2" pipe sizes. Special stainless steel orifice unions can be furnished on special request in 304 or 316 types.

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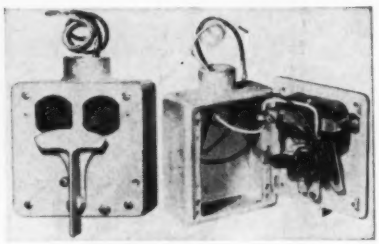
Equipment . . .

two different corrosive media are in process. The interior and exterior of the tubes can be fabricated from the metal best suited to meet corrosive conditions of the media to which it is exposed. More than 125 different bi-metal combinations have been developed and fabricated to solve the corrosive problems arising from such conditions.

The booklet provides information about heat transfer efficiencies, design and installation data, and offers a check list of applications which indicates the metal combinations which best resist attack from generally used corrosive media. Bridgeport Brass Co.

Circle E10 green card, last page



Wall Receptacles Can Be Used In Hazardous Areas

A new line of no-sparking, economical, well-mounted interlock receptacles which permit using any cord set safely in hazardous locations as defined in Class I, Division 2, National Electrical Code, is now offered.

The units are used like ordinary wall plugs. Safety features formerly available only in costly, explosion-proof equipment are provided. The plug can be inserted and locked into the receptacle with no danger of sparking. A positive foolproof safety cam lever locks the plug securely into place. The locking cam operates a tilting mercury bottle switch which prevents insertion or removal of plug while the current is on. The stainless steel Durakool plastic bottles act as safe, hermetically sealed circuit breakers. Bottles are available with straight or twist-lock receptacles. Panellit, Inc.

Circle E11 green card, last page

24-Page Literature Index Cites Instrumentation Data

The new Honeywell Index of Literature is now available. This 24-page bulletin lists Industrial and Valve division literature. Product catalogs contain operating principles, instrument characteristics, application data, general specifications and ordering information. Specifications provide detailed specifications on an instrument or series of instruments. Technical bulletins deal with fundamental studies of instrumentation, and engineering aspects relating to application of an instrument to a specific process or industry. Industry bulletins cover instrumentation as applied to an entire industry. Systems bulletins describe in-

HOW TO SOLVE
heat transfer problems

Here is the book to give you a quick view of heat transfer fundamentals and the calculations of applying them in the design of such equipment as feed-water heaters, condensers, boilers, internal-combustion engine cylinders, and fan coils. Emphasizes basic aspects and immediately useful calculations!

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Engineers encountering a growing number of problems in this field will appreciate the directness of the treatment. Third edition includes new chapters on fluid flow in the convection process and graphical and numerical methods applied to heat conduction problems.

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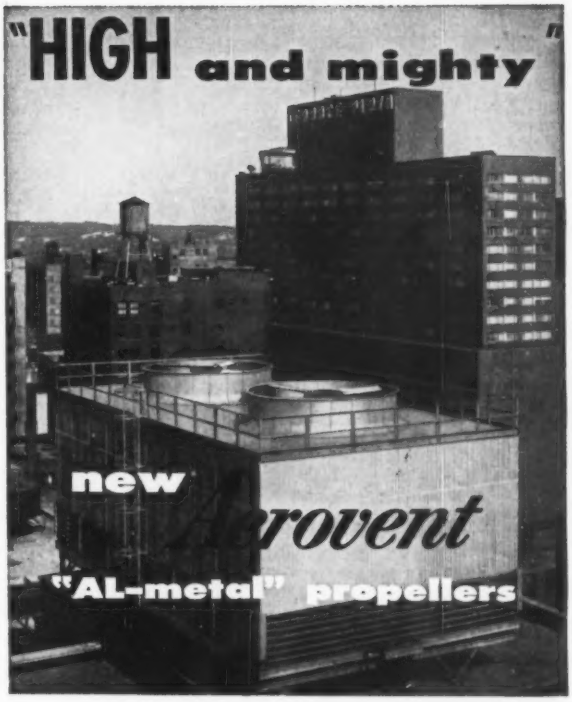

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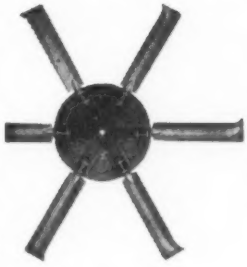

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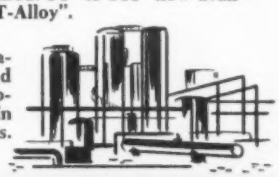

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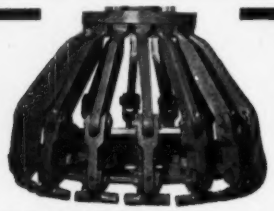
Equipment . . .

strumentation concerning a particular system. Instrumentation data sheets report actual application of instruments on particular processes in specific industries.

A complete alphabetical subject-company index of Instrumentation magazine articles is included. In addition, educational aids and other Honeywell services and literature are described. Minneapolis-Honeywell Regulator Co.

Circle E12 green card, last page



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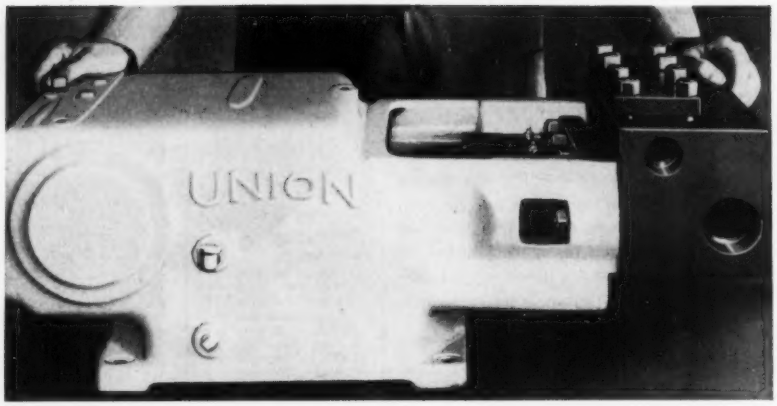


Pump Features 10-HP Continuous Service

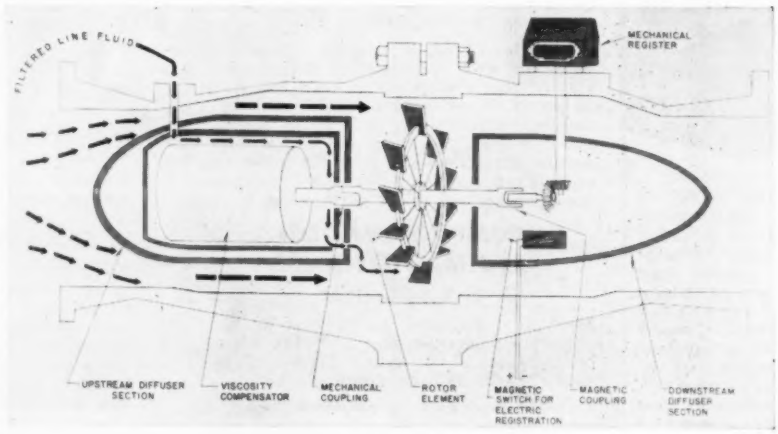
A new Series TX-10 Triplex Power Pump enjoys many new and improved features over other pumps. It is unique because of its compact size and extreme versatility in nearly all fields.

The pump was designed for 10 horsepower continuous input rating. For intermediate service, the pump is rated to 12½-horsepower for the equivalent of 10 hours per day. The continuous plunger load rating at normal horsepower is 1,100 pounds, but will handle intermediate service up to 1,375 pounds. Its horizontal-type design affords a compact, quiet running, easily-installed power pump.

As for the fluid end features, the smaller capacity pumps, such as the TX-10 design, have an excess clearance problem. The manufacturer has eliminated this problem in the TX-10 by reducing inlet losses, greatly reducing volumetric clearance in its fluid cylinder. This especially-designed fluid cylinder has inlet valves operating in line with plungers and the inlet flow directly in line with the plungers.

Other TX-10 features on the fluid cylinder are: interchangeable stuffing boxes interchangeability of suction and discharge valves, bolted forged steel valve covers, and suction and discharge openings on both sides of the cylinder. Union Steam Pump Co.

Circle E13 green card, last page



Continuous Viscosity Correction in Meter

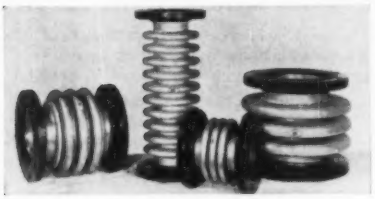
A 16-inch, 15,000 bph capacity positive "screw displacement" meter, superior in accuracy, reliability and flexibility to any positive displacement meter or any high flow capacity meter now on the market has been developed.

Heart of the Turbo-Meter is the 4-pound, ball bearing suspended turborotor which functions as the metering element. The rotor blades are specially designed, low drag, air foil sections upon which the liquid flow impinges. On the upstream end of the rotor shaft is mounted a newly developed viscosity compensator. The device provides a viscous brake type effect to mechanically

impose a drag on the turbo-rotor. The drag is directly proportional to the viscosity of the liquid stream being measured. The result is to fix the amount of turbo-rotor slippage and maintain a constant relationship between the flow velocity and the rotor speed, regardless of viscosity.

To provide a continuous viscosity correction, a small portion of the full line flow is continuously fed through the viscosity compensator. The diverted liquid is then returned to the line flow upstream of the measuring element, to be measured with the line flow. Rockwell Manufacturing Co.

Circle E14 green card, last page



Bellows Expansion Joint Have Test Rated Cycle Life

Tube Turns has announced it will enter the field of flexible piping components with a complete line of bellows expansion joints that have a test-rated cyclic life.

Initial production of stainless steel bellows expansion joints will be in 3 to 30-inch nominal pipe sizes for applications up to 275 psi and 750 F.

A principal application for bellows expansion joints will be where restricted space makes it uneconomical or impossible to install expansion loops to absorb pipe expansion and contraction. Such piping is employed in steam distribution, petroleum refineries, lines conveying chemical vapors and hot gases, and natural gas services. It is also used extensively to provide flexibility in short piping connecting process equipment so that expansion, contraction, vibration and misalignment do not impose excessive stresses, such as in steam turbines with vacuum condensers, distillation and evaporation facilities and vapor processing units in refineries.

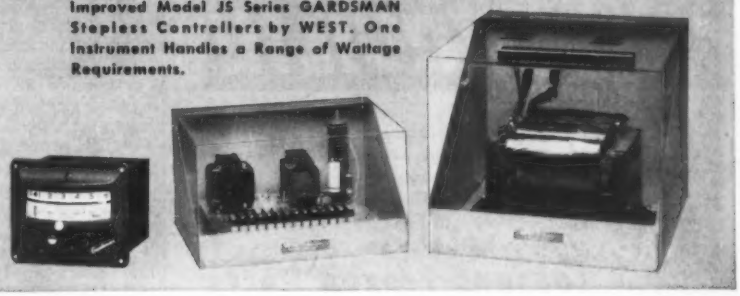
Other cases cited where bellows expansion joints may be preferable to conventional methods included:

- Limited available-pressure drop, such as some catalytic oil refining processes that rely on the thermal head to keep the fluid moving and require short, straight piping to keep pressure drop at a minimum.
- Peculiarities of the fluid, also occurring in certain refining processes where the catalyst, carried in suspension, would tend to drop out in long horizontal runs, restricting flow area and leading to rapid erosion at constrictions or changes of direction.
- Large pipe sizes requiring such large loops or offsets to provide flexibility that

Stepless temperature Control

NOW! TUBELESS, MULTI-LOAD

Improved Model JS Series GARDSMAN Stepless Controllers by WEST. One Instrument Handles a Range of Wattage Requirements.



★ Closest Control
★ Save power
★ Prolong Heater Life
★ Adjustable Band
★ Manual Reset
★ Simplest Operation—One Knob
★ Least Maintenance

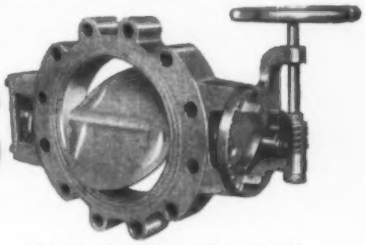
Without tubes or relays, this unique instrument *modulates* input to suit demand. Proved in wide use. Write for Bulletin JS.

4357B W. Montrose Ave.
Chicago 41, Illinois

WEST *Instrument* **CORPORATION**
CHICAGO
SALES OFFICES IN PRINCIPAL CITIES

ROCKWELL

"WAFER" VALVES

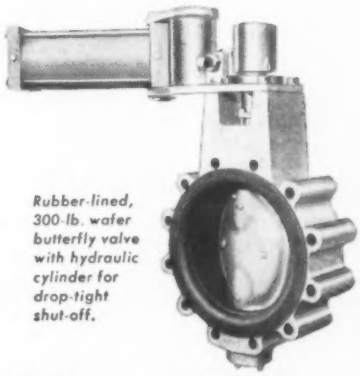


■ *LOWER IN FIRST COST*
■ *NEED MINIMUM SPACE*
■ *EASY TO OPERATE*

Standard 125-150 lb. wafer butterfly valve with handwheel; also available with lever control or mechanical operators.

For controlled throttling or tight shut-off of air, gases, process fluids or semi-solids, Rockwell Wafer Butterfly Valves offer the advantages of rugged construction, compactness, small face-to-face dimension to fit in minimum clearance between pipe flanges.

Write for Bulletin 580.



Rubber-lined, 300-lb. wafer butterfly valve with hydraulic cylinder for drop-tight shut-off.

ROCKWELL SINCE 1888 BUILT

W. S. ROCKWELL COMPANY
Valves - Butterfly · Slide · Diaphragm · Special
2369 ELIOT STREET • **FAIRFIELD, CONN.**

For more data on advertised products, use Readers' Service Cards, last page.

Don't spoil it. KROIL it!

Don't ruin a valuable piece of equipment merely because some part is rusted tight. Apply *KROIL*, the amazing new chemical lubricant that creeps into millionth inch spaces (proved by laboratory tests), dissolves rust, supplies necessary lubrication and . . .

Loosens Frozen Parts

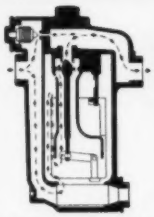
18,000 of America's leading plants can't be wrong. They have used KROIL for ten years and depend on it to save expensive labor and valuable parts. They say: "Kroil loosened bushings after a 12-ton press had failed" . . . "on repairing heat treat trolleys formerly destroyed every nut. Now Kroil saves them all, and time, too."

You too can get these results. Try KROIL on money-back basis. Gallon, $4.00; with Kroiler squirt gun, $4.95, f. o. b. factory.

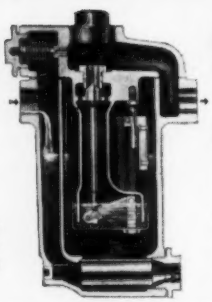
Ask for GENIUS AT WORK—a free publication full of ideas for maintenance men.

KANO LABS. 1094 Thompson Lane Nashville 11, Tennessee

Now—A Steam Trap that Adjusts Automatically to Every Operating Condition!



Warm-up speeded by discharge through by-pass as well as main orifice.



In-line installation. All parts serviced without removing body from line.

AUTOMATICALLY REGULATES FOR FASTER WARM-UP AND TO KEEP OPERATING TEMPERATURE AT PEAK HEAT

Proven bucket design with built-in accessories. By-pass thermostat increases discharge for warm-up and overload conditions. Thermostat compensated to operate at 10° below saturated steam temp. Wright-Austin Airxpel principle provides for mechanical discharge of air after Thermostatic by-pass has closed.

WRITE FOR BULLETIN 808

WRIGHT-AUSTIN COMPANY

3245 WIGHT STREET • DETROIT 7, MICH.

NO LUBRICATION . . . NO WEAR . . . NO MAINTENANCE

After more than 12 months' service the Fluorogreen rings in this compressor are performing with equal or better efficiency than new cast iron rings. Prior to installation of Fluorogreen rings, a costly lubricant containing no hydrocarbons was required for the cast iron rings.

COMPRESSOR AND SERVICE DATA:

Bore	11"
Pressure	6000 psi
Temperature	320 deg. F.
Product	Nitrogen
Rod Diameter	2.530"
Rings	14 FLUOROGREEN Compression rings and 2 wear rings
Rod Packing	FLUOROGREEN Cup and Cone, 6 glands

Fluorogreen is John L. Dore' Company's registered trademark for their filled Teflon.

John L. Dore' Co.
5406 SCHULER • P. O. BOX 7772 • HOUSTON 7, TEXAS
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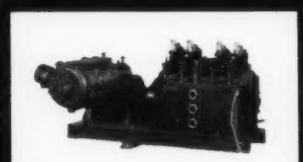
DU PONT'S TEFLON
HI-QUALITY NYLON

HIGH PRESSURE LUBRICATION

MANZEL

The accepted source for lubricator requirements up to 30,000 psi will also solve your other lubrication problems. Manzel's outstanding dependability is built into every model. Experienced field engineers at your service.



HOUDAILLE INDUSTRIES, INC. *Manzel*

285 Babcock Street
Buffalo 10, N. Y.

Specialists in metering pumps and lubricators since 1898

they might impose unusual problems of cost, space and support.

• Cost, particularly where expensive alloy piping material is involved. Tube Turns Div. of Chemetron Corp.

Circle E15 green card, last page

No Sealants Required With O-Ring Tubing Fitting

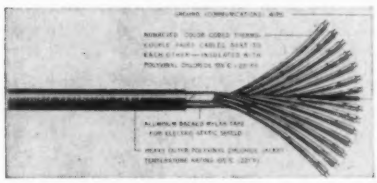
An entirely new type of O-Ring Seal fitting with tapered pipe threads, permitting connection to an existing female pipe thread and securing a positive seal without the use of messy, contaminating sealants, has been made.

The O-Ring Seal in this new Swagelok Fitting is built integrally into the body of the fitting. When tightened against its mating surface, the seal eliminates the possibility of even the smallest leak. This permits use of the new fitting for pressure connections or high vacuum applications with the most rigid leak-proof requirements.

Designed for use in standard female pipe thread connections, the new pipe thread male connectors and adapters can be installed in a few seconds time. No counterboring is necessary. No special tools are required. Simple tightening with an ordinary wrench assures a positive, leakproof seal.

The male connectors and adapters are available in all machinable metals and plastics in sizes for 1/16 through 1-inch O.D. tubing. The O-Ring Seal can be furnished in a variety of materials to meet specific requirements. The Crawford Fitting Co.

Circle E16 green card, last page



Cable Holds Up To 56 Thermocouple Conductors

Thermo-Cable, a new type of polyvinyl insulated multi-conductor cable for 6 to 56 pairs of thermocouple conductors, has been developed.

Individual conductors are insulated in the highest grade, high temperature (221 F.) polyvinyl chloride and then concentrically cabled with over-all polyvinyl chloride insulation. Aluminum-backed Mylar tape, wrapped around the conductor bundle, provides electrostatic shielding. Thermo-Cable is made from either 20 or 16 solid wire, or in 17 gage stranded construction when extra flexibility is required.

Each conductor is color-coded according to ISA recommendations, frequently eliminating the necessity of "ringing out" circuits. Thermocouple pairs are numbered alike and lie next to each other. Thus, no matter where Thermo-Cable is skinned, for termination or other purposes, individual pairs, and negative and positive conductors can always be easily identified.

All cables contain a copper wire which serves as either a ground or communications wire. All standard thermocouple materials are available and ISA accuracy limits for thermocouple extension wire is guaranteed. Thermo-Cable is available with either 6, 14, 18, 25, 39 or 56 pairs of thermocouple conductors. Multi-junction terminal boxes, designed to accommodate the cable are also being made available. Thermo Electric Co., Inc.

Circle E17 green card, last page

Motor Operated PRV Controls Pressure and Flow

Now available are 4 and 6-inch pilot operated pressure reducing valves with patented sliding gate and plate seats. Line-pressure operated regulators give tight shut off, accurate control and minimize maintenance with self-lapping, self-cleaning sliding gate and plate seats. They are capable of handling 50,000 pounds of steam per hour, 2,300 gallons of water per minute or 15,000 cubic feet of air per minute. Suitable for pressures to 125 psi wsp and temperatures to 406 F., the main valve is cast iron with 125 pound ASA flanges. The pilot valve is cast iron with screwed ends. OPW-Jordan.

Circle E18 green card, last page

Operator Works On Small Globe And Gate Valves

A compact, economical and dependable LimiTorque operator for use on small (normally hand-operated) globe and gate valves—either new or already in service has been developed. Existing hand-operated valves can now be easily motorized by the removal of the hand-wheel, and mounting the P-2 unit on the same bonnet . . . the unit output drive sleeve will then drive the hand-wheel unit, which arrangement is suitable for both rising and non-rising stem valves.

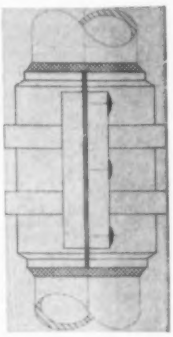
The operator has a standard output speed of 22.5 or 45 rpm, which covers the average and recommended operating speed for most globe and gate valves. Philadelphia Gear Corp.

Circle E19 green card, last page

Equipment . . .

Pipe Repairs Made Easy Using Split Coupling

A new product especially designed for pipe line repairs, the Smith Split-Coupling, will be introduced at the International Petroleum Exposition, May 14-23, Tulsa.



The versatile split-coupling is split longitudinally and can be used as a coupling, split sleeve or as a pipe repair clamp.

Clamping means are provided to resist endwise pull of the pipe when it is used as a coupling. The coupling is all steel and can be welded solidly and permanently—while pipe line is in service—to become an integral part of the pipe line. It is welded to the pipe by full encirclement welds, which are necessary on all newer high-tensile strength pipe lines, whether the device is used as a coupling, repair clamp or a split sleeve.

The only assembly work required in the field is placing the two halves of the Smith Split-Coupling around the pipe and tightening the side bolts. This makes underwater repairs especially easy. Gaskets, installed at the factory as an integral part of the coupling, are held in position so that leaking oil or gas will not displace them during installation.

The Smith Split-Coupling will be available in sizes 2 inches through 4 inches. The Pipe Line Development Co.

Circle E20 green card, last page

Plug Valve Can't Stick Because It's Not Tapered

A new valve, field tested severely up to 15,000 psi, is stronger and 40 percent lighter than conventional tapered plug valves, needs approximately 50 percent less turning force, can be overhauled in the lines, and can be used in lubricated or non-lubricated service.

The new valve never needs adjustment and cannot stick because unlike most high pressure plug valves, it is not tapered. The valve has a straight cylindrical seat, with an ingenious segmented design.

The plug's corrosion-resistant hard seating surface fits into a set of four metal segments serving as replaceable seats in the valve body. The seats are locked together and float slightly due to their synthetic elastomer backing. Under pressure, the seal segments rest metal-to-metal against the body.

No plug adjusting nut is needed, as there are no adjustments to be made. Hammer Valves, Inc.

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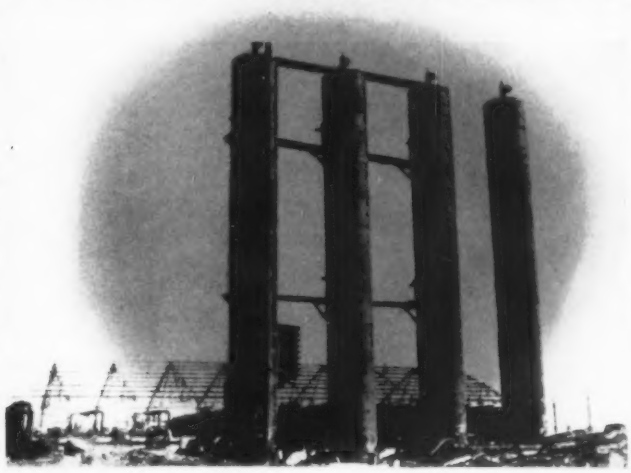
DOMINANT *THEN AS NOW*

In the quarter century since this advertisement was printed, Wyatt Metal & Boiler Works, Inc. has grown to international status with four fabrication plants which have "furnished all the steel plate work" for scores of natural gasoline plants over an area manyfold greater than two counties in Texas.

WYATT METAL & BOILER WORKS



4 7'x60' Absorber Towers in Hanlon Gasoline Plant at Breckenridge

We have furnished all the steel plate work for thirty-one Absorption Gasoline Plants erected in Eastland and Stephens Counties, Texas, within the past eighteen months.

The work has included more than one hundred Absorber Towers and 200 Pressure Storage Tanks in addition to Dephlegmators, Accumulators, Stills, Vent Tanks, etc. Not one failure in the plate work in all the list has been reported.

We solicit inquiry for all classes of plate work requiring skilled and experienced construction.

Wyatt's Dallas

Wyatt Metal and Boiler Works

Dallas, Texas

Printed in Refiner and Natural Gasoline Manufacturer (now Petroleum Refiner) May, 1924.

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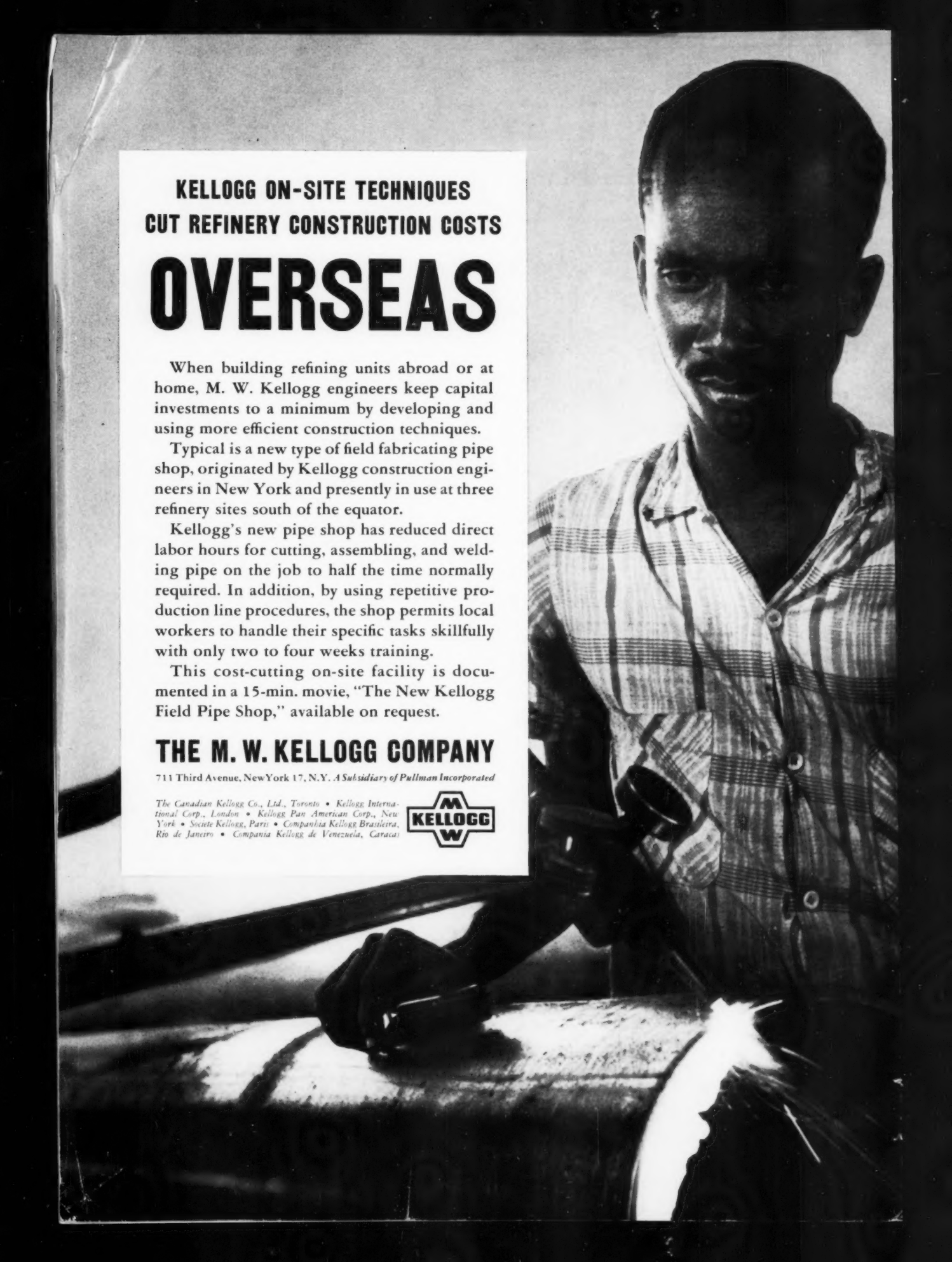

KELLOGG ON-SITE TECHNIQUES CUT REFINERY CONSTRUCTION COSTS

OVERSEAS

When building refining units abroad or at home, M. W. Kellogg engineers keep capital investments to a minimum by developing and using more efficient construction techniques.

Typical is a new type of field fabricating pipe shop, originated by Kellogg construction engineers in New York and presently in use at three refinery sites south of the equator.

Kellogg's new pipe shop has reduced direct labor hours for cutting, assembling, and welding pipe on the job to half the time normally required. In addition, by using repetitive production line procedures, the shop permits local workers to handle their specific tasks skillfully with only two to four weeks training.

This cost-cutting on-site facility is documented in a 15-min. movie, "The New Kellogg Field Pipe Shop," available on request.

THE M. W. KELLOGG COMPANY

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